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GUIDE TO ALTITUDE DECOMPRESSION SICKNESS RESEARCH

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This report is designed to be a reference for Aerospace Researchers and Technicians in the US Air Force who are tasked to perform altitude decompression sickness (DCS) research. It contains information about procedures, records, and equipment used in DCS research at Brooks AFB/City-Base from 1983-2005 involving over 3000 human subject exposures. Although the environmental conditions were different for each profile, the procedures used to gather and record data were standardized. The appendices provide procedural checklists and forms related to the performance of altitude DCS research.

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PREFACE

The purpose of this document is to provide a guide and reference for USAF Researchers and Technicians for how decompression sickness (DCS) research was performed in the US Air Force from 1983-2005 at Brooks AFB/City-Base under the auspices of the USAF School of Aerospace Medicine, the Armstrong Laboratory, and the Air Force Research Laboratory. Facilities are described and forms used for organization and data recording are included. Together with the USAFSAM Altitude Decompression Sickness Research Database (MSAccess) and its description in "Documentation for the USAF School of Aerospace Medicine Altitude Decompression Sickness Research Database" (AFRL-SA-BR-SR-2009-0007), a complete picture of this major research effort is provided.

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GUIDE TO
ALTITUDE DECOMPRESSION SICKNESS RESEARCH

SUMMARY

Accomplishment of decompression sickness (DCS) research requires considerable coordination and teamwork. It involves many steps prior to the first exposure and meticulous attention to detail to ensure the results can be duplicated and built upon with additional research. The use of human subjects requires strict adherence to many layers of guidelines designed to protect both the subjects and the usefulness of any data from their exposure to more than minimal risk. The work at Brooks from 1960 to 2009 involved over 3000 human subject exposures, and the database containing the data gathered during those exposures represents a very large body of information. The documentation of that database is described in detail in: AFRL-SA-BR-SR-2009-0007.

The group of researchers at Brooks AFB/City-Base, TX worked for over 45 years with the criteria described above as their guide. This report is designed to be a reference for Physiology Researchers and Technicians in the US Air Force who are tasked to perform altitude DCS research. It is based on the Brooks history of such research and contains information about procedures, records, and equipment used in that research. Although the environmental conditions were different for each profile, the procedures used to gather and record data were standardized. The appendices provide procedural checklists and forms related to the performance of altitude DCS research.

INTRODUCTION

The purpose of this guide is several fold: (1) provide documentation of the methodology used at Brooks, (2) allow consistent methodology in the future, (3) assist personnel in developing a research program that includes a potential for development of altitude decompression sickness symptoms, and (4) provide a one-source document for review of activities/forms/worksheets.

To make appendices easier to identify and find and make updates easier to accomplish, the appendices are arranged in alphabetical order at the end of the guide and are *italicized and underlined* in the body of the guide. The Table of Contents will also list them in alphabetical order.

Fig 1. Chamber "C" at Brooks AFB/City-Base, TX

Subject-Specific Procedures

Subject Recruiting

Subjects were recruited by:

1. Advertisements in local base newspapers and/or base bulletins
   a. Randolph AFB
   b. Brooks City-Base
   c. Lackland AFB
   d. Fort Sam Houston
2. Word-of-mouth by current/previous subjects

Subject Initial Briefing, Qualification, and Training

The *ARTS Initial Briefing* was designed to acquaint potential Altitude Research Test Subjects (ARTS) with qualifications for participation, descriptions of the physical exam and training required, and a generalized description of the research purpose, risks, typical procedures, benefits of participation, and subject responsibilities. This briefing took place prior to scheduling any new subjects for a test subject physical or physiologic training. If the potential subjects wished to participate after receiving the *ARTS Initial Briefing*, the subjects were given a packet consisting of:

1. An *ARTS Worksheet*
2. A base map showing where the physical exam would be conducted
3. *ARTS Supervisor Consent Letter* (if military) [or a Contractor letter on *Drug and Alcohol Testing Policy; Contract Subjects*]
4. A *Summary of Decompression Sickness Research*
5. A *Medical Records Review Memo* explaining their responsibility and procedures to accomplish the required physical exam by the FSO
6. A *Medical Care Memo*
7. An *ARTS Health History Worksheet,* which would become part of their *Subject Exposure History Folder* and might reveal limitations that would obviate their participation prior to further examination

Test Subject Physical Exam

Subjects were scheduled for a Test Subject Physical Exam at the 311th MDS/SGP (4-2859 see *Contacts*) as discussed in the *Medical Records Review Memo*. Successful completion of the exam allowed an AF Form 1042 (valid for 1 year or until another 1042 is issued) to be completed. The completed AF Form 1042 indicating physical qualification as a test subject had to be delivered to the ARTS manager for the subject to qualify and be scheduled for the Altitude Research Training and altitude research chamber protocols as a test subject.

Physiological Training

Subjects were scheduled for an Altitude Research Training (ART) class consisting of a half-day lecture and training exposure to 35,000 ft (< 1 hr) through USAFSAM/FEEP (see *Contacts*) as scheduled by a Research Technician or Chamber Operations Technician. The ART might also have been conducted by USAFSAM Altitude and Acceleration Operations personnel. A letter from AFMOA/SGOA (18 Feb 99) approved an exception to training to allow a modified, shorter lecture portion based on AFI 11-403 requirements for altitude exposure ONLY. Subjects were not given a Physiological Training Card (AF Form 1274; orange) after completion of this training. Successful completion of the ART allowed participation as a test subject for 3 years and covers the material outlined in the *Altitude Research Training Course* appendix. After this period, training was completed again if the subject continued participation. The ART covers physiologic and safety aspects of exposure in hypobaric chambers and, due to its omission of other training, was not adequate for any other use.

The two items required prior to scheduling a potential subject for an ART class were: (1) a signed 1042 indicating the potential subject is physically qualified to be an altitude research test subject and (2) a signed supervisor's consent form indicating the potential subject may participate.

Air Force Fitness Assessment

The Air Force Fitness Assessment is a sub-maximal cycle ergometry test that takes about 8-14 min (2-min warmup at 1 kp for males and 0.5 kp for females, followed by increasing resistance based on age, gender, height, weight, and indication of activity level) and is administered under Air Force Instruction 10-248, Fitness Program (25 Sep 06). The value derived via their computer program is an estimate of maximal oxygen uptake ($\mathbf{V}O_{2max}$) in mL/kg/min and was converted to L/min for USAFSAM DCS Database entry. The L/min from the database was used to develop tailored exercise levels for subjects doing graded exercises, usually on an ergometer or dual-cycle

ergometer. The Subject Menu/EEP-3 Exercise Worksheet derived its output based on the L/min from the Air Force Fitness Assessment and the subjects' gender and age.

ARTS Safety Training

Prior to initial exposure, subjects completed safety training by chamber personnel. The record of that training was initialed by the trainer and filed in their *ARTS Record* in the Chamber Operations office. Chamber Operations personnel helped new subjects complete an *ARTS Worksheet* used to brief and track subjects' qualification currency. The worksheet in checklist form facilitated sequential familiarization with the area and chamber, safety procedures, the subjects' responsibilities regarding maintenance of qualification, and scheduling and cancellation procedures and was signed by the test subject and trainer.

ARTS Protocol Briefing

It was sometimes necessary to re-brief subjects with the *ARTS Initial Briefing* to ensure they were familiar with their responsibilities before participation in any specific protocol. The *ARTS Protocol Briefing* was protocol-specific and described what was required of the test subject to include specific training (exercise, etc.) involved; number of exposures; duration of exposures; activity before, during, and after the exposures; and any other pertinent information. The subject was shown and demonstrated the ability to complete any routine exercises involved. Usually the subject completed any training no later than the day before the exposure. The subject took an Informed Consent Document (ICD) home and brought it back before any exposure. At that time, the subject signed the ICD in the presence of an uninvolved witness who also signed the ICD. A copy of the signature page of the ICD was placed, with the *Day of Exposure Worksheet and Subject Briefing*, in the *Subject Exposure History Folder*. Maintenance and submission to the IRB administration office of all original ICDs were the responsibility of the Principal Investigator. During conduct of any protocol, the original ICDs were filed in the protocol ICD folder in the designated filing cabinet.

Subject Scheduling

A technician scheduled the subjects for participation in any altitude DCS research protocol according to the *ARTS Scheduling Procedure*. Provided a sufficient number of subjects were available, the maximum number of subjects who could simultaneously complete a profile (two in most protocols) was scheduled along with a backup subject each exposure day. If possible, subjects were scheduled 2-3 weeks in advance of exposure date to give adequate time to both subjects and supervisors. The *Sample Email to Notify ARTS of Next Month's Schedule* describes procedures used to request participation of subjects. An MSExcel file was updated as changes occurred to show scheduled subject cancellations in red font with abbreviated reason on the same line. The scheduling board for the week in the Chamber Operations Conference Room was updated as soon as practical after the Excel file had been updated. A list of current subjects and what exposures they **had completed** was available via the menu-driven DCS database (DCS.mdb). A list of current subjects and what exposures they **needed** was available via the menu-driven DCS database (DCS.mdb).

Subject Records

Subject exposure records consisted of several folders:

1. The *ARTS Record*, which contained training and other qualification information, was subject to the Privacy Act of 1974 (locked files).

2. *Subject Exposure History Folders* were kept in the contractor lab.
3. Hypobaric exposure records (Research Chamber Flight Records, including AF Forms 361) were kept by Altitude and Acceleration Operations.
4. Subject medical records were kept by the local FSO.
5. Contractor medical records were kept in the contractor lab.

Day Before Exposure

Research Technician Responsibilities

1. Check scheduling board for subjects' names and appropriate protocol.
2. Ensure the subjects' names are not on the DNIF list posted by the scheduling board.
3. Remind female subjects to accomplish a pregnancy test as briefed.
4. Ask the subjects which movies they would like to watch.
5. Acquire movies as appropriate (possibly on Day OF Exposure).
6. Prepare/load the Research Technician's cart for the next day's data collection, to include:
   a. Current/appropriate SVHS tape for protocol (or new one)
   b. *Experimental Data Worksheet* (in notebook) for protocol
   c. *Subject Exposure History Folder*
   d. Robotic arm key
   e. Subject's lab smock
   f. Cut drinking tube, placed in plastic bag (sandwich bag), marked with subject's name
   g. If a copy of the signature page of the most recent ICD for the protocol is not in the *Subject Exposure History Folder*, a copy of appropriate ICD (current ICD masters are maintained by the Investigators) should be included
7. Check with Life Support to ensure appropriate Intertechnique mask is ready.
8. *Day of Exposure Worksheet and Subject Briefing* on clipboard. Fill in name of subject on *Day of Exposure Worksheet and Subject Briefing* with appropriate protocol, profile, and Mask #; place near the chamber for the subject to fill out on day of exposure.
9. Ensure appropriate *Protocol-Specific Equipment and Exercise Procedures* are ready and set.
10. Attempt to complete appropriate Body Composition Worksheet (gender) for each subject. Use procedures in Body Composition Assessment (gender) descriptions to complete the worksheet.
11. Ensure adequate drink supply is available for the subject.

Chamber Technician Responsibilities

1. If subject is female, call (or schedule via internet) the FSO and order a pregnancy test for altitude flight.
2. Insure chamber equipment and gas supply are available and ready for the next day's exposure.

Morning-of-Exposure Procedures

Research Technician Responsibilities

1. Subject records rechecked.
2. *Day-of-Exposure Worksheet and Subject Briefing* signed.

A questionnaire covering the previous day's activities, degree of restfulness (sleep), and recent meals is completed prior to each subject's exposure. Some protocols require that each subject sign and date a written briefing on DCS symptoms prior to each exposure. This procedure is in lieu of questioning the subject during the exposure about physical status, pain, etc.

3. Informed consent document (ICD) signing if not on file.
   The current, signed, original ICD shall be filed in Rm. 133 in the protocol/ICD folder and a copy of the signature page with footer protocol title and date will be filed in the Subject Exposure History Folder.
3. Record blood pressure and weight of subject on *Day-of-Exposure Worksheet and Subject Briefing*.
4. Mask selection and fitting as necessary.
5. Medical monitor examination.

Chamber Technician (Supervisor or Designee) Responsibilities

1. Obtain the *ARTS Record* from the HEPG Altitude and Acceleration Operations Administrative Support office.
   a. Ensure adequate AF Forms 502, blank *Medical Record*, for medical monitor's use are appropriately filed.
   b. Place the folder in the exam room.
2. Subject briefing by chamber personnel as required.
   This is a chamber procedures and safety briefing including use of the lock, etc. as covered in the *Flight Supervisor Altitude Research Checklist-Preflight*.
3. Mask fitting as necessary.
   Each subject will be fitted for an alternate (usually an aviator mask) mask to be used in the event of symptom development and return to ground-level pressure. The Intertechnique mask will be doffed and checked for leaks by chamber personnel while the subject uses an alternate mask for post-breathe of 100% oxygen.

CHAMBER DESCRIPTIONS, CAPABILITIES, AND PROCEDURES

Brooks Chambers

The altitude (hypobaric) research chambers at Brooks (AFB/City-Base) were installed in the early 1960s, and extensive NASA-funded research was conducted in them until the Manned Orbiting Laboratory effort was terminated in the late 1960s. They continued to be used for some NASA research and human/equipment testing for the USAF. The descriptions, capabilities, and listings of some of the research protocols conducted in them are shown in *Brooks AFB/City-Base Altitude Chambers*.

Test Plan and Normal Chamber Operations

A detailed test plan (See *Sample Test Plan*) exists for each protocol and describes, in checklist format, the items specific to each profile of each protocol that need to be accomplished and in what time frame. An *Experimental Data Worksheet* is used by the Research Technician to record data regarding the subject, exposure, and subject reactions. The *Medical Record* (AF Form 502) is annotated by the Medical Observer/Monitor as appropriate during the pre- and post-exposure examinations. An ear and sinus check is accomplished as the first decompression for any DCS research exposure. The chamber is decompressed at 5,000 ft/min to 5,000 ft, where a communications check is accomplished to include verbal assurance that each subject's ears cleared normally. Recompression to ground-level pressure is accomplished at 5,000 ft/min after minimal, usually less than 10 seconds, time at 5,000 ft.

To minimize confusion about timing during the active protocols, the following description should be of assistance.

Start Mission Clock

This time defines the beginning of the experiment. All other times should relate to this time.

The ***Start Mission Clock*** time is the earliest of when:

1) The subject's breathing mixture is changed (e.g., beginning prebreathe by changing breathing mixture from air to 100% oxygen).

2) The subject's environmental pressure is changed (e.g., the subject begins ascent during a zero-prebreathe exposure).

Restart Mission Clock

This time defines the beginning of the exposure at the exposure altitude, not the stage altitude or ascent to altitude, for example, arrival at 25,000 ft for the N2O2 study or 30,000 ft for the Break-in-Prebreathe Study. The reasons for this are the frequent questions that arise about how long the subject has been at altitude, which is nearly always defined as how long the subject has been at the highest exposure altitude as defined in the protocol. Restarting the mission clock a minimum number of times is desired because it minimizes the need for someone to be waiting, with mouse in hand, at the computer to reset the mission clock at the second needed and reduces the cumulative errors involved with any lapse in these operations.

Decompression rate for DCS research protocols is protocol-specific and should be shown in the test plan for each profile. Communications checks are accomplished during ascent, and subjects are monitored for any problems during ascent and the

ensuing time while decompressed. If the chamber exposure is delayed, the test plan may be followed by picking it up at whatever clock time the chamber arrives at the protocol-stipulated altitude. However, the protocol-stipulated time at altitude must remain the same; hence, time must be added to the end of the test plan in the event of a delay. The same "ritual" of activity must be followed at the end of the exposure as would have been done if the exposure had begun on time.

Termination of research chamber subject exposures will be in accordance with the *Chamber Exposure Termination (Recompression) Criteria* guidelines.

Postflight Procedures

Complete the *Flight Supervisor Altitude Research Checklist-Postflight*. Subjects normally accomplish a 2-hr post-breathe with 100% oxygen after recompression to ground level. At the end of the subject's post-breathe period, the chamber personnel monitoring the subject after the exposure should give the subject a postflight briefing and record the subject's postflight weight (following post-breathe) on the *Day-of-Exposure Worksheet and Subject Briefing*. A subject who has DCS which resolves on descent is Doppler monitored for bubbles every 10 min, after arrival at ground level, until bubbles are no longer detected. If DCS is not relieved by recompression to ground level, the subject's condition will be reported to Hyperbaric Medicine, who will determine and accomplish the appropriate treatment. A *Subject Contact Information Card* is given to each subject and contains contact and symptom information in the event his/her condition changes after release.

Some protocols may allow shorter post-breathe periods depending on exposure severity and duration of prebreathe. Check the appropriate protocol for this information.

DATA RECORDING AND DATABASES

Data from the research exposures are recorded on *Experimental Data Worksheets* (in notebooks) which, with supporting information from the *Day-of-Exposure Worksheet and Subject Briefing* and chamber records, serve as the basis for entering information about each subject exposure in the USAFSAM Altitude DCS Research Database. The database also has information on each protocol, including a short description which is pertinent to *Subject Appreciation Letters*. Locations of the USAFSAM *Altitude Decompression Sickness Research Database* and *Altitude Decompression Sickness Literature Database* are described in *Location of Altitude Decompression Sickness Research Files*. The USAFSAM *Altitude Decompression Sickness Research Database* is sufficiently complex to require separate documentation in AFRL-SA-BR-SR-2009-0007 “Documentation for the USAF School of Aerospace Medicine Altitude Decompression Sickness Research Database.” The much simpler *Altitude Decompression Sickness Literature Database* is adequately documented in the appendix bearing its name.

Body Composition Assessments are accomplished and data from the *Body Composition Worksheets* are entered into the database.

ROBOTIC ARM PROCEDURES

Power-Up

1) Power up the terminal. The rocker switch is located under the front right edge of the terminal near the power LED.
2) Make certain both Emergency-Stop buttons are not depressed.
3) Insert the power key into the control power switch and rotate to the right. The white power light will light.
4) Remove the key and insert the teach pendant key into the pendant's key slot. The monitor will ask: Initialize? Enter N (no). Never initialize as this would remove any user-installed programs such as x-form.
5) Turn on the arm power by rotating the arm power switch to the right. The orange light will begin to flash. While it is flashing, the blue arm power activate button must be pressed. If the blue button is not pressed while the light is flashing, you must turn off the arm power and begin again.
6) At the teach pendant, select computer mode with the key switch.
7) At the monitor type: DO READY (enter). The arm will emerge from the nest (stowed position) and proceed to the ready position.
8) At the teach pendant, select the manual mode with the key switch.
9) Select TOOL mode or JOINT mode as needed.
10) The arm is now ready for use.

Note: Always use slow speed on robot when approaching the subject and for most adjustments.

Movements of the Robotic Arm in the Tool and Joint Mode

JOINT MODE: Each key moves each individual joint (1-6); Large movements

TOOL MODE: Fine adjustments

X Key – moves the entire arm left and right
Y Key – moves the entire arm up and down
Z Key – moves the entire arm closer and farther to the subject
4 Key – points probe up and down
5 Key – points probe left and right
6 Key – rotates probe

Power-Down (Finished Using Robotic Arm)

1) Turn off the teach pendant with the key.
2) Make sure nothing is obstructing movement of the arm, e.g., the exam table, trash, etc.
3) Type: **DO READY**; press "New Line" key on the computer.
4) **WAIT** until robotic arm stops moving.
5) Type: DO NEST; press "New Line" key on the computer.
6) **WAIT** until robotic arm stops moving.
7) Turn off the computer.
8) Deactivate the robotic arm.

Robotic Arm Calibration

The robotic arm will only generally require recalibration after the arm has been jolted or operated outside its normal range. If the arm has been forced to move without first pressing the brake release button, the encoders have slipped and will require recalibration.

1) Depress and hold the brake release button located at the base of the arm.
2) While holding the brake release button gently manipulate the arm into its nest position. Be certain the alignment marks for each segment are correctly oriented.
3) Turn on the arm power by rotating the arm power switch to the on position. The amber light will begin to flash. The power-on button must then be pressed while the light is still flashing.
4) At the terminal, type LIMP and depress the enter key three times or until you hear a relay click in the controller cabinet.
5) Type CAL, Are You Sure? Y.
6) The arm will now calibrate and beep when finished. The arm will also move out of the nest position and be ready for use. If it does not cal properly, check the alignment of the arm in the nest and try the cal again.

NOTES:

1. Operator error has been the only cause for the arm to go out of calibration. Operators should be extremely careful not to operate the arm outside its normal range or not to “bump” the arm against anything (i.e., Doppler table).
2. Instruct subjects not to touch the robotic arm. If an emergency occurs (i.e., operator loses control of arm), the subject can deactivate the arm by applying slight pressure to the arm.
3. To relocate the robotic arm, ensure that the arm is turned off and in the “nest position.” Also ensure that the cord/cable is not bent!
4. Arm should always be turned off and in the “nest position” when not in use!

HP SONOS 1000 PROCEDURES

Subject and Flight Input

The HP SONOS 1000 records both visual and auditory signals via a probe passed through the chamber wall.

1) Turn Sonos on and wait a few seconds for instrument to go through self check.
2) Press L for configuration.
3) Select protocol by appropriate letter.
4) Press Approve.
5) Press Approve.
6) INSERT APPROPRIATE TAPE.
7) Press shift; begin; return; shift; 1; then type info; press approve twice.
8) Press shift; tape#; type frame #; press approve.

Data Recording

1) Switch intercom to position #3.
2) Once a good image is obtained, press the "PW" button[1].
3) Press "TAPE" button.
4) Turn on microphone from Sonos by pushing the button on the microphone.
5) Record (say into microphone) clock time _____; mission time _____; and subject #.
6) Turn on hot mike (intercom).
7) Press foot paddle to speak with subject.
8) Ask subject to move right arm, left arm, right leg, and left leg. If a large # of VGE are present, wait until most VGE have subsided before asking subject to move next joint.
9) Move sound tracking ball to different area so subject does not hear VGE sounds.
10) Press "STOP" button.
11) Press "PW" button.
12) Turn off microphone.
13) Turn off hot mike (intercom) and lower volume.
14) Switch to intercom #1.

VGE Recording Procedures

The type of transducer used depends on the patient being examined. For our purposes a 2.0 or 2.25 megahertz (MHz) transducer is used. This particular frequency represents a good compromise between penetration and resolution.

[1] The best available image is recorded as a ground-level control for the exposure. Once a satisfactory echo-image is obtained, begin recording and continue recording until the probe is removed from the subject.

Subjects will be instructed to wear clothing which allows access for placement of the ultrasonic probe near the sternum. For observing all four chambers, the optimal echocardiographic image is obtained by having the subject lie on his or her left side (Fig. 2). This position brings more of the heart to the left of the sternum. Ultrasound gel (Aquasonic) is applied directly to the combined echo-imaging and Doppler ultrasound probe as a coupling medium. Irrespective of where the transducer is placed there must be airless contact between it and the skin. The transducer should be positioned with the "red dot" on the transducer facing up.

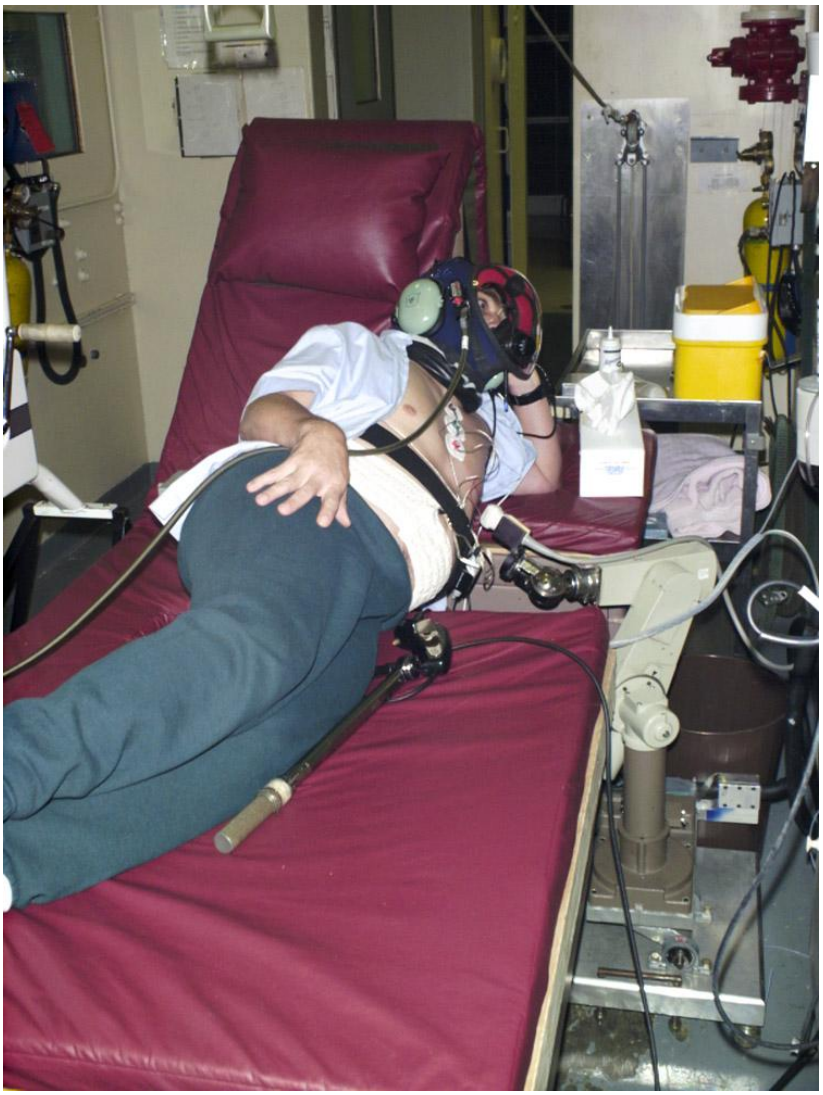

Fig 2. Picture of Subject in Correct Position for Monitoring on Echo-Imaging Table with a Robotic Arm Holding the Echo-Imaging Probe

The probe is usually positioned at the subject's 3rd intercostal space on the left side for a parasternal, short-axis view of the heart. This view allows clear observation of all four chambers of the heart while the probe is aimed at the apex of the right ventricle. The best echocardiographic window is usually found 3 to 4 cm left of the sternum between the 4th or 5th intercostal space. Body size, organ placement, and structure variations may cause the window to vary somewhat among subjects down to the 2nd intercostal space. The angle of the transducer being rotated to right or left will vary with each individual to obtain the optimum image. The echo-image provides guidance and

visual feedback for probe orientation by observing the echo-image on the monitor facing the chamber viewing port.

If the resulting echo-image is unclear, the probe and subject are moved in attempts to acquire a better image (optimal acoustic image). There are echographic controls on the ultrasound instrument that are used to enhance the image, i.e. making the image larger or smaller; increasing or decreasing the intensity of light; setting up the depth compensation or TGC. Once an optimum image is obtained, use a “sharpie” marker, usually blue or red, to draw an outline around the transducer as a guide for the operator to use once the transducer is placed in the robotic arm holder, again with the “red dot” on the transducer facing up, before ascending to altitude.

VGE Grading Scale

Subjects are monitored for intravenous gas bubbles graded by the Spencer Scale[2] (Spencer, 1976) using both the echo-image and Doppler ultrasound information.

Table 1. Spencer Scale for Grading VGE

Spencer Grade	Spencer (1976) Description	VGE/ min[3]	Exponential Method[4] VGE/h VGE/min
Zero	No bubble signals.	0	0-9 0-.01
I	An occasional bubble signal. The great majority of cardiac cycles are free of bubble signals.	0-15	10-99 .02-1
II	Many, but less than half the cardiac cycles, contain bubble signals.	15-29	100-999 2-16
III	Bubbles in most of the cardiac cycles but not obscuring the heart sounds.	30-?	1,000-9,999 17-166
IV	Numerous bubbles that obscure the heart sounds	?	10,000+ 167-1,666

Frequency of VGE Recording

A ground level recording is taken immediately prior to prebreathe or ascent/decompression as stipulated in each protocol time schedule. The frequency and duration of VGE monitoring will depend on the exercise scenario and specific procedures of the protocol.

[2] VGE (Spencer, 1976) Grades 3 & 4 are defined here as severe VGE. The Air Force Research Laboratory records on 119 exposures to 29,500-30,000 ft show that over 95% of the exposures resulting in VGE and DCS had Grade 3 or 4 VGE. Grade 1 or 2 VGE are, therefore, not considered severe.

[3] The bubbles/min approximation is based on a heart rate of 60 beats/min and represents the estimated range of bubble numbers using the Spencer method.

[4] The exponential method (Webb, 1990) sets 10^n as the VGE/h; the resulting "n" is roughly equivalent to the Spencer Grade in terms of bubble count per unit time. It is dependent upon an ability to count the number of bubbles in each unit of time observed; an ability not currently available.

Webb JT. Decompression hazards research. In: Aircrew Life Support Systems Enhancement (Krutz RW Jr, et al.). USAFSAM-TR-89-26. 1990;4-9.

REFERENCES

US Air Force School of Aerospace Medicien Altitude Decompression Sickness Research Database.

Spencer MP. Decompression limits for compressed air determined by ultrasonically detected blood bubbles. J. Appl. Physiol. 1976;40:229-35.

Webb JT. Documentation for the USAF School Of Aerospace Medicine Altitude Decompression Sickness Research Database. USAFSAM-SR-2009-0007.

Webb JT. Decompression hazards research. In: Aircrew Life Support Systems Enhancement (Krutz RW Jr, et al.). USAFSAM-TR-89-26. 1990;4-9.

Webb JT, Krutz RW Jr, Dixon GA. An annotated bibliography of hypobaric decompression research conducted at the Crew Technology Division, USAF School of Aerospace Medicine, Brooks City-Base, Texas from 1983 to 1988. USAFSAM Technical Paper 88-10R. 1990;22pp.

Webb JT, Pilmanis AA. Venous gas emboli detection and endpoints for decompression sickness research. 29th Annual SAFE Symposium Proceedings. 1992:20-3.

APPENDICES

The appendices are in alphabetical order. See the Table of Contents, pages iii-iv, for the page number of a specific appendix.

ALTITUDE RESEARCH TRAINING COURSE
(3 Year Currency)

To become qualified for Test Subject activities and pay, you have completed your physical, turned an AF Form 1042 into the Research Technician, and are now required to complete classroom and chamber training by attending an Altitude Research Training (ART) course. You are scheduled to attend the ART course on:

at 0730 (7:30 a.m.) at:

Please respond by Accept or Reject as soon as practical.

This class will last all day. The uniform of the day is BDUs or a flight suit, if authorized. For civilians, the dress should be casual and comfortable (discretion is appreciated).

The next ART course may be 4-8 weeks after the one you have been scheduled to attend. Please the Research Technician if you have any questions. Thank you for your cooperation.

Class schedule

0730-0745:	Sign-In
0745-0915:	Intro/Atmosphere/Respiration & Circulation
	Hypoxia/Hyperventilation
	Effects of Press Change
0925-1025:	Self Imposed Stress & Fatigue
1030-1100:	Oxygen Equipment
1100-1115:	Intertechnique Mask Orientation
1215-1300:	Cabin Pressurization
1300-1315:	Pre-flight Briefing
1315-1330:	Equipment Issue
1330-1350:	O2 Lab
1350-1500:	Type II/I
1500-1515:	Post-flight Briefing/Critique

ALTITUDE DECOMPRESSION SICKNESS LITERATURE DATABASE

The Altitude DCS Literature Database is a relational, one-table database which can produce reports and downloads with a few clicks of menu buttons. The database is, as of this writing [13Nov08], in MSAccess 2003 format.

Research using the database of 1800 articles relevant to DCS is menu-driven, although a basic understanding of MSAccess 2003 structure and function is assumed. Data entry and retrieval has been made relatively easy via menus and drop-down lists. Extracting a list of references which deal with a particular subset of information about DCS is possible using the menu based on keywords. A complete keyword listing is provided below. Any resulting report can be printed or exported via File/Export, although MSAccess2003 is limited to producing non-MSWord files in .txt or .rtf format.

Table 2. Keywords Used in the Altitude DCS Bibliographic Database

abstract	accident	age	aircraft
aircrew	anthropometric	argon	ascent
asymptomatic	biochem	blood	bone
breath-hold	bubble	Canada	cavitation
chamber	chokes	clinical	CO2
complement	DCS	death	decompression
dehydration	delayed	denitrogenation	descent
detection	diagnosis	diet	diffusion
Doppler	drug	ebullism	echo-image
emboli	equilibration	etiology	EVA
exercise	experimental	extra	fat
female	fitness	flight	gender
growth	helium	hormone	human
hyperbaric	hypobaric	hypoxia	incidence
injury	interface	interruption	intra
in-vitro	isobaric	male	mammal
metabolic	model	NASA	necrosis
nitrogen	non-mammal	nucle-	operational
oxygen	pathology	performance	perfusion
platelet	prebreathe	prediction	primate
prophylaxis	protection	pulmonary	rapid
rate	reascent	recompression	repeat
review	saturation	SCUBA	selection
shuttle	skin	smoking	solubility
Soviet	spinal	steroid	stress
suit	supersaturation	surface	surfactant
susceptibility	symptom	table	technique
temperature	tendon	toxicity	training
treatment	TypeII	USAF	USN
vascular	VGE		

ALTITUDE DECOMPRESSION SICKNESS RESEARCH DATABASE

The USAFSAM Altitude DCS Research Database is a relational, multi-table database which is fully described in AFRL-SA-BR-SR-2009-0007, Documentation for the USAF School of Aerospace Medicine Altitude Decompression Sickness Research Database. This database contains all data acquired during the 3000+ human subject exposures conducted between 1983 and 2005.

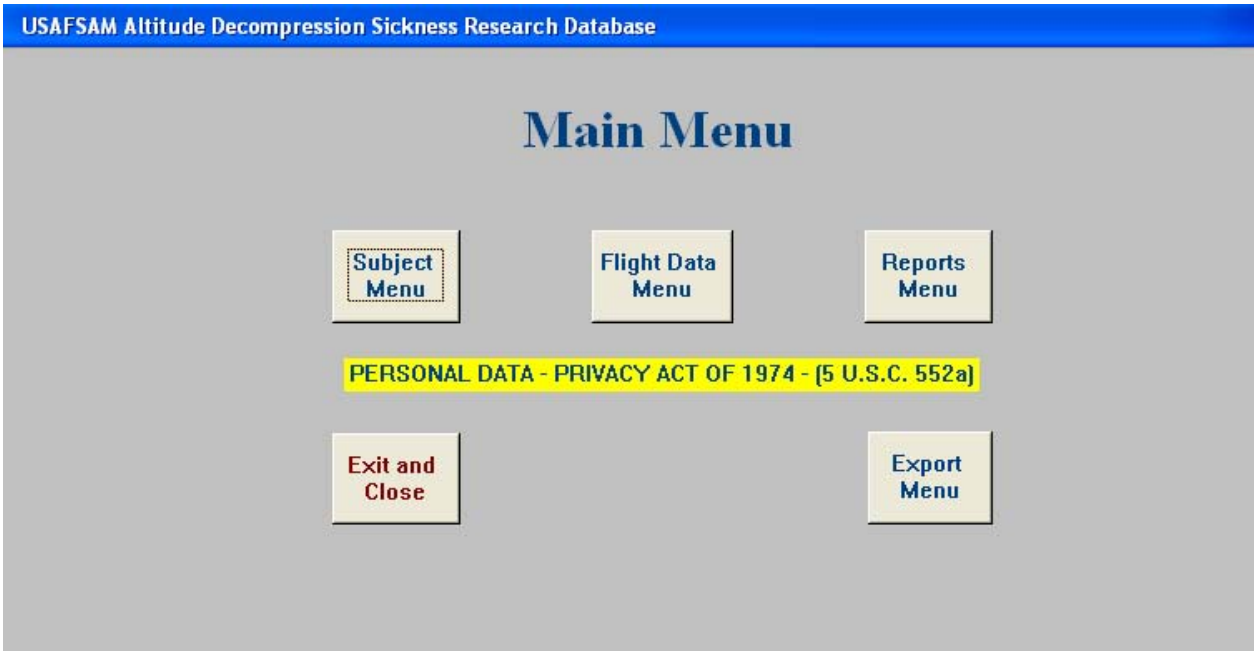

Fig. 3. Main Menu of the Altitude DCS Research Database

The database is menu driven and will produce reports on all protocols accomplished in the 23 calendar years of research data acquisition and recording. The database was used to acquire data for development of the Altitude DCS Risk Assessment Computer (ADRAC) model described in Pilmanis et al. (2004).

Pilmanis AA, Petropoulos L, Kannan N, Webb JT. Decompression sickness risk model: development and validation by 150 prospective hypobaric exposures. Aviat Space Environ Med 2004; 75:749-759.

ARTS HEALTH HISTORY WORKSHEET
FOR OFFICIAL USE ONLY *(Information Subject to the Privacy Act of 1974)*

Name: _____

1. Describe your past injury history (broken bones, sprains, operations, etc.)
Date (Mo/Yr) Injury/Operation and Location (R, L, area, etc.) Treatment (Cast, etc.)

_____ _____ _____

_____ _____ _____

_____ _____ _____

2. Usual level of physical activity (circle one):

SEDENTARY ACTIVE ATHLETIC OTHER

3. Describe your typical weekly exercise activity and frequency

_____

_____

4. Tobacco use history (circle one): NEVER FORMER USER If you currently use tobacco, you may not participate in altitude research exposures. If you are a former user, how long since your last use? _____. If you have used cigarettes, how many packs per day did you average? _____, for how many years? _____. If you have used tobacco, other than cigarettes, describe that use, type and quantity:

_____

5. Alcohol use history (circle one): NONE LIGHT MODERATE HEAVY and category (circle one or more): WINE BEER DISTILLED

6. List all medications you take regularly and are taking now:

Medication Dosage Frequency

_____

_____

_____

7. Are you now or do you have any plans to be qualified as aircrew for the USAF?

Yes No

Subject Signature _____ Date _____

Research Technician Initials _____

ARTS INITIAL BRIEFING

Research Technician Briefing to Potential ARTS

1. Test Subject Qualifications (Typical Requirements)

Between 18 and 50 years of age
Tolerant to exercise, depending on protocol
Not pregnant or anticipating pregnancy
Meets standards of body fat in accordance with Air Force Instruction 10-248 (Fitness Program; 22Aug07); 3-site caliper method by Research Technician (see *Body Composition Worksheet*)
- Males ≤ 29y, ≤ 20%
- Males ≥ 30y, ≤ 24%
- Females ≤ 29y, ≤ 28%
- Females ≥ 30y, ≤ 32%

Otherwise representative of USAF pilot and NASA mission specialist population
- HIV negative
- Routine drug screen negative
- Non-smoker for preceding 2 years

2. Description of Physical Exam and Training Required

Pass ARTS Physical Exam (similar to Flying Class III)
USAF Altitude Research Training (ART) course (1 or 2 days)
Protocol training (exercise familiarization, research chamber safety procedures, echo-imaging practice; 1-4 periods, depending on protocol; 20-40 min each)

3. Description of Research Purpose, Risks, Typical Procedures, and Benefits

Our goals are to define safe altitude exposure limits and support development of aircrew protection equipment and procedures. Our main customers are the U.S. Special Operations Command and NASA.

The major risk is decompression sickness (DCS) which typically involves mild pain that resolves completely during descent to ground-level pressure; however, a wide variety of symptoms are possible. The following table lists the most common symptoms other than pain.

Pain or tightness in a joint	Blurred vision	Difficulty breathing
Fuzzy feeling in the head	Dizziness	Chest pain
Unexpected fatigue	Weakness	Chest tightness
Skin itching or tingling	Coughing	Headache

The exposures to simulated altitude in our altitude chambers typically involve some form of preoxygenation (prebreathing) which involves breathing 100% oxygen for a period of time to reduce the level of nitrogen gas in tissues and blood. Nitrogen gas causes symptoms when it forms bubbles in your tissues under some exposure conditions, with or without preoxygenation. The typical ascent rate is 5,000 feet per minute, requiring some jaw movement or swallowing to equalize pressure in your middle ear as the

pressure around you decreases. Some form of exercise is usually accomplished at altitude which lasts for the duration of the exposure, 1-5 hours. Monitoring for venous gas emboli (VGE) in the heart will be accomplished by use of a robotic arm in the chamber, manipulated by a technician outside the chamber. The robotic arm holds an echo-imaging probe against the chest (suitable clothing must be worn to allow access for probe placement). This is a benign procedure routinely used to look at fetuses and for other routine clinical purposes. Descent is usually at 5,000 feet per min and typically requires some form of Valsalva to equalize pressure in the middle ear as instructed during physiological training. Subjects normally post-breathe (breathe 100% oxygen after exposure) for approximately 2 hours.

The benefits to subjects include monetary amounts of $150/month of participation (at least one exposure in each month for Hazardous Duty Pay if you are military; pro-rated on first month of participation) or $15.45/hour on the day you are exposed to altitude as a civilian contract subject. Also considered a benefit is knowing that subjects are contributing to the growth of knowledge about DCS risk in various aerospace environments. This factor may be applicable for inclusion in performance evaluations.

4. Review of Subject Responsibilities

a. Complete medical screening with Flight Surgeon
b. Receive *ARTS Initial Briefing*
c. Obtain supervisor's signature on *ARTS Supervisor Consent Letter*
d. Complete the top portion of the *ARTS Worksheet*
e. Complete an *ARTS Health History Worksheet*
f. Provide a copy of AF (or Army) Fitness Program Individual Assessment Report showing $\mathbf{VO}_{2Max}$ score or submit to a submaximal ergometry test
g. Schedule Physical Exam which is described in the *Medical Records Review Memo* and obtain an AF Form 1042 indicating clearance to participate
h. Complete the Research Subject Training Course (frequently called the ART, Altitude Research Training course)
    1) AFI 11-403 Aerospace Physiological Training Program (20Feb01)
    2) Material in paragraphs 6.1.1.-6.1.5. and 6.1.13 only, as per AFMOA/SGOA letter (18Feb99) and USAFSAM Supplement
    3) Areas covered are: Physiological effects of altitude; human performance; oxygen equipment; cabin pressurization and depressurization; pressure breathing; and prechamber flight indoctrination
    4) Type 1 and Type 2 chamber flights
    5) Certification in this course qualifies an individual to fly (be exposed) in an altitude chamber only
i. Receive briefings:
    1) Initial
    2) Protocol
    3) Safety
j. Sign an Informed Consent Document (ICD) before participating in any protocol

ARTS PROTOCOL BRIEFING

Research Technician Briefing to ARTS

DAY BEFORE EXPOSURE

a. Review, take home overnight, and sign informed consent document (ICD) if not on file

b. Avoid gas-producing foods (beans, spicy foods, etc.) for 72 hours before exposure

c. Limit alcohol to minimum within 72 hours and to zero within 18 hours of exposure

d. No self-medication for flu, cold, etc. If you become ill, please inform us ASAP to allow rescheduling; many people's schedules are affected by changes.

e. NO FLYING OR DIVING WITHIN 72 HOURS BEFORE OR AFTER EXPOSURE

f. Plan to get a good night's rest before the exposure (NO WORK FOR COMPENSATION WITHIN 8 HOURS OF REPORTING FOR EXPOSURE)

g. Limit exercise within 12 hours of exposure. Do not increase activity, duration, or resistance. Do not perform exercises that are not part of your normal exercise routine.

DAY OF EXPOSURE

a. Avoid gas-producing foods (beans, spicy foods, carbonated beverages, etc.)

b. Eat a breakfast low in fats and protein. Cereals, pancakes, toast, are OK.

c. Limit caffeine to minimum needed to avoid adverse symptoms (e.g., headache)

d. Avoid exercise that is not part of the protocol

e. Sign informed consent document (ICD) if not on file

f. Exposure duration is 1-8 hours; please make use of the bathroom prior to the exposure to limit interruptions of the exposure to use the urinal/portable toilet in the chamber.

g. Wear comfortable clothing which allows access to the area where the echo-imaging probe will be placed during exposure. Females are requested to wear a suitable "bikini top" underneath the shirt to facilitate echo imaging.

h. Please be on time. If you are going to be late, please call the protocol technician () or the flight supervisor ().

i. If you must cancel the exposure/flight, please notify the Research Technician or the flight supervisor IMMEDIATELY. Schedule changes affect many people. Please try to notify us at least 24 hours prior to the scheduled flight.
j. Preoxygenation times vary depending on the protocol profile being accomplished; 0 – 4 hours; resting or with exercise graded to subject capacity.

DURING EXPOSURE

a. Immediately notify an observer or other chamber/medical personnel if any change in well-being including any of the following symptoms occur during or after the exposure:

Pain or tightness in a joint	**Blurred vision**	**Difficulty breathing**
Fuzzy feeling in the head	**Dizziness**	**Chest pain**
Unexpected fatigue	**Weakness**	**Chest tightness**
Skin itching or tingling	**Coughing**	**Headache**

b. A medical monitor and aerospace physiologist will be in the area during your exposure to provide assistance and observation for any symptoms not noticed by any subject.

c. For echo-imaging procedures, see Section V

d. For test termination criteria, see Section III

e. Post-breathe with 100% oxygen begins immediately after recompression and usually lasts for 2 hours. During this time subjects typically read or watch television. (see Section III)

ARTS RECORD

The ARTS Record is maintained by the HEPG Altitude and Acceleration Operations Administrative Support office in Bldg. 160 and is set up in a multi-part folder for each subject.

Part I

- AF Form 1042 (Medical Recommendation for Flying or Special Operational Duty)
- AF Form 702 (Individual Physiological Training Record)
- Subject's Information (ARTS Worksheet)

Part II

- Signed protocols (original kept by Principal Investigator iaw IRB directives)

Part III

- Blank SF Forms 502 (Medical Record)

Part IV

- Completed SF Forms 502 (Medical Record)
- AF Forms 361EF (Chamber Reactor/Treatment Report)

Part V

- Supervisor Consent Letter
- DD Form 2005, Privacy Act
- Safety Briefing Form
- Personal Pictures Consent Form

Part VI

- DD Forms 114 (Military Pay Order)
- Certified Orders
- Special Orders
- Request for Orders

ARTS SAFETY TRAINING CHECKLIST

By Chamber Technician

1. _____Briefed on reporting symptoms of altitude DCS
2. _____Area Familiarization:
    a. Exam Room
    b. Rest Room
    c. Pre-Breathe Station
    d. Emergency Exits
3. _____Chamber familiarization, to include:
    a. Lock
    b. Intercom System
    c. Fire Extinguisher Locations
    d. Restroom Facilities
    e. French (Intertechnique) Mask/Emergency Mask
    f. Emergency Procedures
4. _____Maintaining Qualifications
    a. Flight Physical (good for 1 year unless grounded; DNIF)
    b. Altitude Research Training (ART) Class (good for 3 years)
    c. HDIP – pro-rated during first and last month, $150/month otherwise
5. _____Scheduling
    a. Points of Contact
        1. Research Technician
        2. Chamber Personnel
    b. Cancellations (ASAP)
6. _____Preparing for your flight
    a. No makeup to include petroleum-based products (i.e. Chapstick)
    b. No nail polish
    c. No hairspray/gel
    d. No gas producing foods the night before or morning of (stay hydrated)
    e. Wear cotton clothing to include undergarments
    f. Emergency contact numbers
7. _____I received the FSO guidance regarding medical clearances, maintenance of medical records, DNIF status, and return to flying status.

Trainee's name (print): _____

Trainee's signature: _____ Date: _____

Trainer's signature:_____ Date: _____

ARTS SCHEDULING PROCEDURE

TO: Altitude Research Test Subjects
FROM: Principle Investigator
SUBJECT: ARTS Scheduling procedure

1. Thank You! Your participation as Altitude Research Test Subjects makes possible improved definition of high altitude hazards and development of better protective measures. Some of these better protective measures have been applied to:

    - U-2 high altitude reconnaissance operations where some at-risk pilots are using procedures developed here to allow them to continue flying, thus saving their reconnaissance careers and the USAF about a million bucks-a-pop in training;
    - NASA extravehicular activity where, in July of 2001, two astronauts commissioned a new procedure based on our findings to reduce their prebreathe time prior to space station construction efforts, saving over $100,000 per hour;
    - Special Operations where crews and (special) passengers will be able to get where they are needed more rapidly and safer due to incorporation of past and ongoing research you support

2. Inclusion of this support in your performance reports may be to your benefit. We can provide a synopsis of the protocol support you have provided during any period of time.

3. Timely accomplishment of our research to support these operations requires maximum utilization of the available chamber and chamber support crew (physicians, researchers, etc.). To do this, a new scheduling procedure for your altitude research exposures has been initiated to provide you with more flexibility while using all of the available (semi-scarce) chamber time. This procedure consists of:

    - Activation of a new monthly scheduling method based on your response. You will be sent an email about two weeks before the beginning of each month. The email will show which days are available.
    - You only need to reply to the email by stating the primary and two alternate days you are available to do a protocol exposure. We will then confirm your choice with a reply email. That email confirmation is the ONLY notification you will get. Please mark your calendar.
    - This is a **FIRST COME, FIRST SERVE** system
    - You will have **10 days** to schedule yourself after receiving the email. After that, you will have to wait for the next month's schedule.
    - This system should minimize the time you spend scheduling your participation with us and help ensure your continued, timely receipt of Hazardous Duty Incentive Pay.
    - Please work with us to make this new system successful and helpful for all of us.

ARTS SUPERVISOR CONSENT LETTER

FROM: _____ DATE: _____

SUBJECT: Permission to participate as an Altitude Research Test Subject in a Hypobaric Research Chamber at :

TO:

_____ (duty phone _____) has my consent to participate as an Altitude Research Test Subject under experimental protocols approved via the Institutional Review Board. This research is in support of aerospace operations including those of the Department of Defense and/or NASA. It is understood that advanced notice will be given to enable necessary changes to the work schedule.

_____
Supervisor's Signature

_____
Supervisor's Name, Grade, Duty Phone

ARTS WORKSHEET

ARTS WORKSHEET - FOR OFFICIAL USE ONLY
(Information Subject to the Privacy Act of 1974)

PART I. SUBJECT'S INFORMATION

1. NAME *(Last, First, MI)*			2. RANK/GRADE	3. TODAY'S DATE
4. ADDRESS *(Home)*			5. ADDRESS *(Work)*	
6. HOME PHONE	7. DUTY PHONE	8. CELL PHONE	9. E-MAIL ADDRESS	
10. SSAN:	11. HEIGHT *(Inches)*		12. SEX	13. BIRTH DATE

(Technician Use Only)

14. ORIENTATION BRIEFING (Date completed)	15. REMARKS

PART II. CHECKLIST FOR TECHNICIAN BRIEFING TO ARTS

1. REVIEW ARTS QUALIFICATION REQUIREMENTS:
   a) Within AF body fat standards.
   b) Non-smoker for at least 2 years.
   c) Return signed ARTS Supervisor Consent Letter.
   d) Pass subjects physical.
   e) Attend physiological training.

2. TIME COMMITMENT: Inform supervisor you will need to be here all day on the day of the exposure, normally once a month. Some protocols involve specific training before the day of the exposure.

3. SAFETY DURING FLIGHT: A PTO and MD will be available to help ensure safety. IO on call during exposure to assist with and maintain all O_2 and communications equipment and watch for any adverse reactions.

4. O_2 MASK: A French mask (hood with neck seal) is used during prebreathe and exposure. During post-breathe you have the option of wearing the French mask or the aviator's mask. *French mask has a drinking tube.*

5. FLIGHT SURGEON: Local flight surgeon will be your primary provider. You will be on "Subject Status."

6. MONETARY COMPENSATION: Hazardous Duty Pay ($150.00/mo, military, at least one flight each month) ($15.45/h, contractor).

7. Other

BODY COMPOSITION ASSESSMENT FOR FEMALES

Background: We use the Jackson-Pollock-Ward (1980) equation for body density prediction using skinfold measurements. This equation is a "generalized" prediction equation which takes into account body density variations associated with age (i.e., age used as an independent variable) and the nonlinear relationship between adiposity and body density (i.e., it is a quadratic model). The Jackson-Pollock equation below has been shown to yield a standard body density estimate ±0.008 $g \cdot ml^{-1}$ and has been repeatedly cross-validated. This particular equation is the equation shown to be used by exercise physiology programs most often on samples similar to ours (Hearon et al., 1991).

Once body density is estimated, the equation derived by Siri (1961) will be utilized to estimate percent body fat. While the Brozek equation (1963) has been shown to be used by the majority of exercise physiology programs (Hearon et al., 1991), the Siri equation has been shown to yield intermediate body fat values when compared to the Brozek equations and others (Lohman, 1981). The Siri equation assumes constant densities of fat-mass (0.90 $g \cdot ml^{-1}$) and fat-free mass (1.10 $g \cdot ml^{-1}$).

Subjects: Caucasian, female, 18-55 yr, ≤44.0% body fat from criterion.

Body Density Estimation: from Jackson, Pollock and Ward (1980)

$$\mathbf{D_b=1.0994921-[0.0009929(SUM)]+[0.0000023(SUM^2)]-[0.0001392(AGE)]}$$

where D_b=body density ($g \cdot ml^{-1}$), SUM=sum of triceps, suprailiac and thigh skinfolds (mm) as measured by Lange calipers and AGE=subject age (yr).

Percent Body Fat Estimation: from Siri (1961)

$$\mathbf{\%BF = [(4.95/D_b)-4.50] \times 100}$$ where %BF=percent body fat and D_b=body density ($g \cdot ml^{-1}$).

General Measurement Guidelines: from Lohman et al. (1988)

1. Measurements should be made at least 7 days following cessation of subject's last menses and at least 7 days prior to the onset of her next menses.
2. Skinfold measurements are to be made by the same observer using Lange calipers.
3. Skinfold measurements should be made on the subject's right side.
4. Skinfolds should be raised using the observer's left hand approximately 1 cm proximal to the measurement site. The fold should be kept elevated until the calipers are placed with the observer's right hand perpendicular to the long axis of the skinfold, a reading made and the calipers removed.
5. The skinfold should be released and re-gathered for each subsequent measurement on a specific site.
6. Readings should be made within 4 s after the complete application of the calipers on the site.
7. Measurements should be repeated until reliable measurements (i.e., acceptable intratester difference as defined below) result at which time a mean of the two

repeated readings should be recorded for data analysis. Therefore, at least two readings will be made at each site.

Site Location: from Lohman et al. (1988)

Triceps: The triceps skinfold is measured with the subject standing erect, arms hanging freely at the sides of the body and palms supinated. The vertical fold is taken at the midline of the posterior portion of the upper arm over the triceps muscle. The site is located at a point midway between the lateral portion of the acromion process and the inferior margin of the olecranon process when the subject's elbow is flexed to 90°. Measurements are recorded to the nearest 1.0 mm. An intratester difference between measurements ≤1.0 mm is considered reliable.

Suprailiac: The suprailiac skinfold is measured with the subject standing erect, feet together and arms hanging freely at the sides of the body with palms facing medially (arms are abducted at the time of measurement if necessary). The diagonal fold is taken just posterior to the midaxillary line superior to the iliac crest. the fold is grasped inclined infero-medially 45° to the horizontal plane. Measurements are recorded to the nearest 1.0 mm. An intratester difference between measurements ≤ 1.0 mm is considered reliable.

Thigh: The thigh skinfold is measured with the subject standing erect, his body weight shifted to the leg not being measured while the leg being measured is relaxed with the knee slightly flexed and the foot flat on the floor. The vertical fold is taken along the midline of the anterior thigh midway between the inguinal crease and the proximal border of the patella. Measurements are recorded to the nearest 1.0 mm. An intratester difference between measurements ≤ 2.0 mm is considered reliable.

References:

Brozek J, Grande F, Anderson J, Keys A. Densitometric analysis of body composition: Revision of some quantitative assumptions. Ann NY Acad Sci. 1963;110:113-40.

Hearon CM, Wolfe DR, Bobo M. Body composition estimation practices in exercise physiology: Possible implications for standardization. TAHPERD J. 1991;60:25-9.

Jackson S, Pollock ML, Ward A. Generalized equations for predicting body density of women. Med Sci Sports Exer. 1980;12:175-82.

Lohman TG. Skinfolds and body density and their relation to body fatness: A review. Human Biol. 1981;53:81-225.

Lohman TG, Roche AF, Martorell R. Antropometric standardization reference manual. Champaign, IL: Human Kinetics. 1988.

Siri WE. Body composition from fluid spaces and density: Analysis of methods in techniques for measuring body composition. In J. Brozek & A. Henschel Eds., Techniques for measuring body composition. Washington, D.C.: National Academy of Science National Research Council. 1961:223-34.

BODY COMPOSITION ASSESSMENT FOR MALES

Background: We use the Jackson-Pollock-Ward (1980) equation for body density prediction using skinfold measurements. This equation is a "generalized" prediction equation which takes into account body density variations associated with age (i.e., age used as an independent variable) and the nonlinear relationship between adiposity and body density (i.e., it is a quadratic model). The Jackson-Pollock equation below has been shown to yield a standard body density estimate ±0.0077 g.ml-1 and has been repeatedly cross-validated. This particular equation has also been demonstrated to be generalized across a range of gross indicators of android/gynoid fat distribution and body physique/proportionality (Hearon, 1995). This particular equation is the equation shown to be used by exercise physiology programs most often on samples similar to ours (Hearon et al., 1991).

Once body density is estimated, the equation derived by Siri (1961) will be utilized to estimate percent body fat. While the Brozek equation (1963) has been shown to be used by the majority of exercise physiology programs (Hearon et al., 1991), the Siri equation has been shown to yield intermediate body fat values when compared to the Brozek equations and others (Lohman, 1981). The Siri equation assumes constant densities of fat-mass (0.90 g.ml-1) and fat-free mass (1.10 g.ml-1).

Subjects: Caucasian, male, 18-61 yr, ≤33.0% body fat from criterion.

Body Density Estimation: from Jackson and Pollock (1978)

Db=1.10938-[0.0008267(SUM)]+[0.0000016(SUM2)]-[0.0002574(AGE)]

where Db=body density (g.ml-1), SUM=sum of chest, abdominal and thigh skinfolds (mm) as measured by Lange calipers and AGE=subject age (yr).

Percent Body Fat Estimation: from Siri (1961)

%BF = [(4.95/Db)-4.50] x 100 where %BF=percent body fat and Db=body density (g.ml-1).

General Measurement Guidelines: from Lohman et al. (1988)

1. Skinfold measurements are to be made by the same observer using Lange calipers.
2. Skinfold measurements should be made on the subject's right side.
3. Skinfolds should be raised using the observer's left hand approximately 1 cm proximal to the measurement site. The fold should be kept elevated until the calipers are placed with the observer's right hand perpendicular to the long axis of the skinfold, a reading made and the calipers removed.
4. The skinfold should be released and re-gathered for each subsequent measurement on a specific site.
5. Readings should be made within 4 s after the complete application of the calipers on the site.
6. Measurements should be repeated until reliable measurements (i.e., acceptable intratester difference as defined below) result at which time a mean of the two

repeated readings should be recorded for data analysis. Therefore, at least two readings will be made at each site.

Site Location: from Lohman et al. (1988)

Chest: The chest skinfold is measured with the subject standing erect, arms hanging freely at the sides of the body and palms facing medially. The diagonal fold is taken with the fold's long axis directed at the nipple at a point midway between the axillary fold and the nipple. Measurements are recorded to the nearest 1.0 mm. An intratester difference between measurements ≤2.0 mm is considered reliable.

Abdomen: The abdominal skinfold is measured with the subject standing erect with body weight evenly distributed on both feet when feet are shoulder-width apart. The horizontal fold is taken 3 cm lateral and 1 cm inferior to the umbilicus. Measurements are recorded to the nearest 1.0 mm. An intratester difference between measurements ≤1.0 mm is considered reliable.

Thigh: The thigh skinfold is measured with the subject standing erect, his body weight shifted to the leg not being measured while the leg being measured is relaxed with the knee slightly flexed and the foot flat on the floor. The vertical fold is taken along the midline of the anterior thigh midway between the inghuinal crease and the proximal border of the patella. Measurements are recorded to the nearest 1.0 mm. An intratester difference between measurements ≤ 2.0 mm is considered reliable.

References:

Brozek J, Grande F, Anderson J, Keys A. Densitometric analysis of body composition: Revision of some quantitative assumptions. Ann NY Acad Sci. 1963;110:113-40.

Hearon CM. The relationship between the accuracy of certain "generalized" body density prediction equations and indices of fatness, body physique/proportionality and fat distribution. Dissertation Abstracts International, 1995;56(11A):4318. (Dialog File # 35 Accession # 1468929).

Hearon CM, Wolfe DR, Bobo M. Body composition estimation practices in exercise physiology: Possible implications for standardization. TAHPERD J. 1991;60:25-9.

Jackson S, Pollock ML, Ward A. Generalized equations for predicting body density of women. Med Sci Sports Exer. 1980;12:175-82.

Lohman TG. Skinfolds and body density and their relation to body fatness: A review. Human Biol. 1981;53:81-225.

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Siri WE. Body composition from fluid spaces and density: Analysis of methods in techniques for measuring body composition. In J. Brozek & A. Henschel Eds., Techniques for measuring body composition. Washington, D.C.: National Academy of Science National Research Council. 1961:223-34.

BODY COMPOSITION WORKSHEET FOR FEMALES

Subject Name: _____ **Subject I.D.:** _____

Study/Protocol: _____ **P.I.:** _____

Date/Time: _____ **Observer:** _____

Age:_____yr_____mos =_____yr (to .01)

Body Mass:_____lb =_____kg (to .01)

Body Stature:_____in =_____cm (to .01)

Time Since Last: Urination/B.M.:____h Food Consumption:_h

Days Since: Last Menses Cessation:_____d Next Menses Onset:_____d

SKINFOLDS

Triceps (to 1.0, ≤1.0 mm): ____ ____ ____ ____ ____ ____ = ____mm

Suprailiac (to 1.0, ≤1.0 mm): ____ ____ ____ ____ ____ = ____mm

Thigh (to 1.0, ≤2.0 mm): ____ ____ ____ ____ ____ ____ = ____mm

SUM = _____mm

BODY DENSITY

D_b=1.0994921-[0.0009929(SUM)]+[0.0000023(SUM^2)]-[0.0001392(AGE)]

_____g.X ml^{-1} (to 0.0001)

PERCENT BODY FAT

%BF = [(4.95/Db)-4.50] x 100
% (to .01)

BODY COMPOSITION WORKSHEET FOR MALES

Subject Name: _____ **Subject I.D.:** _____

Study/Protocol: _____ **P.I.:** _____

Date/Time: _____ **Observer:** _____

Age: yr mos = yr (to .01)

Body Mass: lb = kg (to .01)

Body Stature: in = cm (to .01)

Time Since Last: Urination/B.M. Food Consumption:

SKINFOLDS

Chest (to 1.0, ≤2.0 mm): ____ ____ ____ ____ ____ ____ = ____mm

Abdomen (to 1.0, ≤1.0 mm): ____ ____ ____ ____ ____ = ____mm

Thigh (to 1.0, ≤2.0 mm): ____ ____ ____ ____ ____ ____ = ____mm

SUM = _____mm

BODY DENSITY

Db=1.10938-[0.0008267(SUM)]+[0.0000016(SUM2)]-[0.0002574(AGE)]

_____ g X ml^{-1} (to 0.0001)

PERCENT BODY FAT

%BF = [(4.95/Db)-4.50] x 100

_____ % (to .01)

BROOKS AFB/CITY-BASE ALTITUDE CHAMBERS

The altitude research chambers located at Building 160, Brooks AFB/City-Base, TX (Fig 2) are capable of attaining altitudes in excess of 80,000 ft, with one chamber only capable of ground level thermal simulation. Two chambers are also capable of simulating environmental conditions ranging from -50^0 F to $+150^0$ F combined with a controllable relative humidity schedule. The dimensions, capabilities, and protocol history of the nine hypobaric/altitude chambers are listed below.

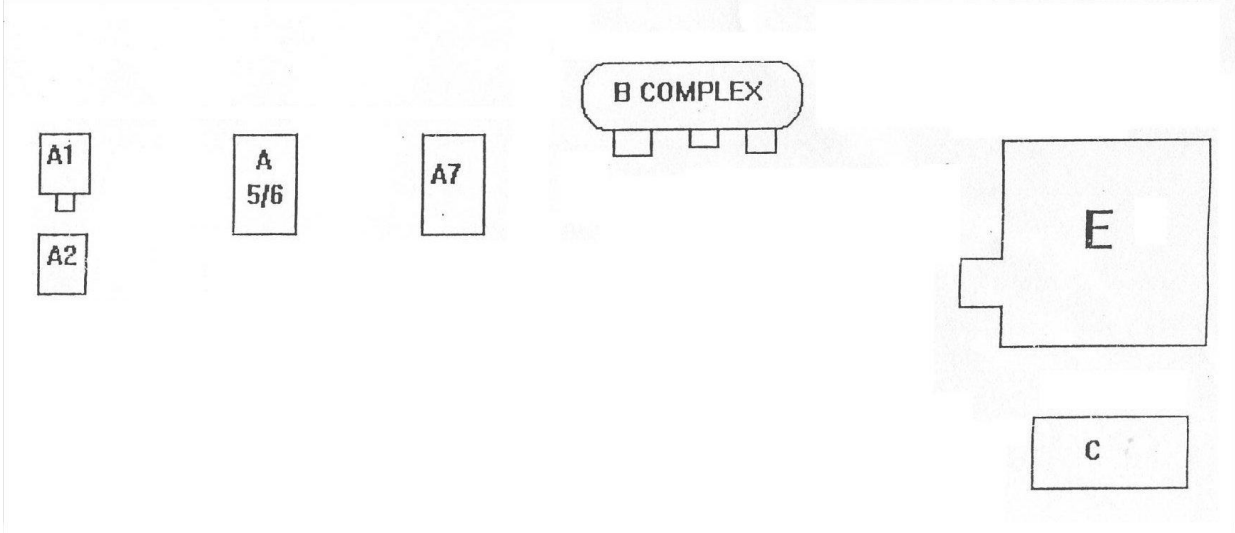

Fig 2. Chambers at Brooks City-Base

Chamber A-1

A-1 DIMENSIONS

Chamber A-1 is a rectangular steel structure containing a main chamber and a lock compartment. Both compartments may be operated jointly or independently of each other. The interior of the chamber is 7 ft in length, 6 ft wide, and 7.25 ft high. The main door opening is 36 inches wide and 6 ft 6 inches high.

A-1 CAPABILITIES

The compartments of simulator A-1 may be evacuated to simulate any desired altitude between ground level and 100,000 ft. Altitude may be controlled either manually or automatically. Nash and Kinney vacuum pumps may be used to evacuate these two compartments. The Nash vacuum pumps can be used for protocols which require an increased oxygen environment because they are water sealed and have a ceiling of 40,000 ft. The Kinney pumps have a ceiling of 100,000 ft. The Nash pumps are capable of maintaining any predetermined altitude for a period of at least one year.

A-1 PROTOCOL HISTORY

Used in support of testing the Combat Casualty Bag (Body Bag) in support of Aeromedical Research Testing. Also used to determine Carbon Dioxide build-up in Chemical Defense Patient Evacuation Bag.

Chamber A-2

A-2 DIMENSIONS

Chamber A-2 is a rectangular steel structure with a single compartment. The interior of the chamber is 7 ft in length, 6 ft wide, and 7 ft 3 inches high. The chamber door opening is 36 inches wide and 6 ft 6 inches high.

A-2 CAPABILITIES

The chamber may be evacuated to simulate any desired altitude between ground level and 100,000 ft. Altitude may be controlled either manually or automatically. Nash and Kinney vacuum pumps may be used to evacuate this chamber. The Nash vacuum pumps can be used for protocols which require an increased oxygen environment because they are water sealed and have a ceiling of 40,000 ft. The Kinney Pumps have a ceiling of 100,000 ft. The Nash pumps are capable of maintaining any predetermined altitude for a period of at least one year. The chamber is configured with a Vibration Test System (VTS) installed that has the capabilities of testing various equipment carried on-board an aircraft. The VTS is used at ground level for medical device testing or at altitude for oxygen equipment testing.

A-2 PROTOCOL HISTORY

Past protocols were an Ozone Study in which the chamber was kept at an altitude of 40,000 ft for six months , eight to ten hours per day for five days per week. Other studies include: Apollo project Support, Astronaut Training, Baby Bird Ventilator/Respirator (developed for Aeromedical Evacuation Purposes), and the On-Board oxygen Generation System (OBOGS) testing.

Chamber A-5/6

A-5/6 DIMENSIONS

Chamber A-5/6 is a rectangular steel structure containing two main chamber compartments and a lock compartment. The interior of the chamber is 15.5 ft in length, 6 ft wide and 7 ft 3 inches high. The door opening is 36 inches wide and 6 ft 6 inches high.

A-5/6 CAPABILITIES

Chamber A-5/6 may be evacuated to simulate any desired altitude between ground level and 100,000 ft. Altitude may be controlled either manually or automatically. Two Kinney vacuum pumps are utilized to evacuate the three compartments. The compartments will reach a simulated altitude of 100,000 ft within 6 minutes, an average rate of climb of 16,000 ft per minute. The Kinney pumps are capable of maintaining and predetermined altitude for a period of at least one year. Chamber A-5/6 is also capable of high altitude rapid decompression from ground level to 100,000 ft or any altitude selected. The rate ant time of decompression can be accurately controlled and provide precise decompression schedules down to one second.

A-5/6 PROTOCOL HISTORY

Chamber A-5/6 is utilized to test various life support equipment either under development or in the Air Force inventory. In past studies the chamber was used as a platform for testing and research for MSOGS (Molecular Sieve Oxygen Generating System) and On-Board Oxygen Generating Systems (OBOGS) for various types of aircraft in the Air Force inventory, such as: B-1, B-2, F-15, F-16, CV-22, JSF, and F-22. The MSOGS system is designed to generate the aircraft oxygen supply,

providing 85% to 95% pure oxygen from ambient air the aircraft is flying through. This chamber may be placed in many different configurations, from as simple as an oxygen regulator with leads to as complex as a test subject on an ergonometric bicycle doing a computer task while at altitude. Testing of G-suits and vests involves rapid decompressions up to 60,000 ft plus on a regular basis. Such tests were used in evaluations of F-22 Combat Edge and F-16 JPATS.

B Complex Chambers

The chamber assembly is comprised of four units; the one-man parasite (B-1), the small equipment parasite (B-2), the large equipment parasite (B-3), and the accumulator. All parasite chambers are directly connected to an accumulator used to attain extremely high altitudes supporting rapid decompressions. The parasites work independently or as a group. Each of these units are described in detail in the following section.

B COMPLEX DIMENSIONS

- (B-1) -= Chamber B-1 is a rectangular steel structure divided into two separate compartments: the main compartment and the lock compartment. The chamber is 8.5 ft long, 65 inches wide and 8 ft high. Total volume is 286 cubic ft.

- (B-2) -- Chamber B-2 is a rectangular steel structure approximately 30 inches by 42 inches by 48 inches. Total volume is 34.5 cubic ft.

- (B-3) -- Chamber B-3 is a rectangular steel structure approximately 42 inches by 42 inches by 48 inches. Total volume is 82 cubic ft.

B COMPLEX CAPABILITIES

All three chambers have the capability of achieving altitudes in excess of 100,000 ft. All parasites can simulate any desired altitude between ground level and 100,000 ft. A simulated altitude of 100,000 ft can be reached in 12 minutes at an average rate of climb of 8,300 ft per minute. The accumulator may be evacuated to simulate any altitude from ground level to 150,000 ft. A simulated altitude of 150,000 ft can be reached in 25 minutes at an average rate of climb of 6,000 ft per minute. The accumulator serves as a vacuum storage tank for all three chambers as well as chamber A-5/6. This is accomplished via a large overhead diameter pipe passing from the B-Complex to Chamber A-5/6. Chamber B-1 is capable of both manned experimentation and equipment tests. B-2/3 are only able to contain unmanned experimentation packages.

B COMPLEX PROTOCOL HISTORY

Chamber B-1 was utilized by the National Aeronautics Space Administration (NASA), to man-rate the Emergency Escape Garment (Partial Pressure Suit) that is currently being worn by Shuttle crewmembers during the ascent and descent stages of a shuttle flight. Volunteer subjects wore the pressure suit to altitudes of over 100,000 ft for extended periods of time in order to validate the design and capabilities of the garment. Other studies include: the Expeditionary Integrated Hood Mask, the Protective Integrated Hood Mask. NASA also utilizes the chamber in support of Space Shuttle Mission Equipment Checks. Chamber B-2 is used to test equipment to be carried in-flight. B-3 has served the purpose of testing life

support equipment to be carried on Air Force Aeromedical Evacuation aircraft and also equipment flown on the Space Shuttle.

E-Chamber

E-CHAMBER DIMENSIONS

The chamber assembly is approximately 33 ft 10 inches wide and 40 ft, 7 inches long with a 7 foot 10 inch main door opening.

E-CHAMBER CAPABILITIES

The chamber may be evacuated to simulate any desired altitude between ground level and 100,000 ft. A simulated altitude of 100,000 ft can be reached in 12 minutes at an average rate of climb of 8,300 ft per minute. The chamber may be controlled either manually or automatically. Not only can this chamber go to altitude (80,000 ft plus), but the chamber's temperature and humidity can be controlled via computer to meet the specific needs of the study/protocol being conducted. The temperature within the chamber may be reduced, at ground level conditions, from ambient temperature to -67^0 F. If desired, the temperature within the chamber may be raised, at ground level conditions, from ambient temperature to $+150^0$ F within 6 hours. The humidity may be varied from 3% to 95% relative humidity.

E-CHAMBER PROTOCOL HISTORY

This chamber was utilized for studies ranging from Chemical Warfare Suit testing, where the chamber environmental conditions were set up to simulate desert to the Firefighter Suit Ensemble study, Contact Lens study, Commercial Aeromedical Evacuation equipment study, Various studies of cooling devices used during Operation Desert Shield/Desert Storm. A very large project entailed checking proper operation and overall capabilities of the Air Force B-1B bomber's entire oxygen system. The large square footage of the chamber was used to mount and test all necessary plumbing and hardware that exists on the B-1B and test the system at various altitudes up to and including 80,000 ft. The effect of altitude and lack of oxygen on the wearer of Night Vision Goggles (NVGs) and effects of hypoxia on PRK surgery recovery, F-16 APECS, F-22 Cooling Garment, U-2 Full Pressure Suit, Aircrew Personal Environmental Control System were also evaluated in this chamber.

C-Chamber

C-CHAMBER DIMENSIONS

C-chamber is a rectangular steel structure (known as a 20-man chamber) which has been modified for research purposes. The interior of the chamber is 30 ft 8 inches in length, 8 ft wide, and 8 ft high. The main door opening is 6 ft 6 inches high by 3 ft wide.

C-CHAMBER CAPABILITIES

The compartments of C-chamber may be evacuated to simulate any desired altitude between ground level and 50,000 ft using 2 Nash vacuum pumps or 100,000 ft using 5 Kinney vacuum pumps. These two systems are used independently with isolation valves. The chamber is structurally able to go to 100,000 ft. Altitude may be controlled either manually or automatically. This chamber has the capability of being kept at altitude for a period of at least one year.

C-CHAMBER PROTOCOL HISTORY

This chamber is used primarily for Decompression Sickness (DCS) studies and measuring the effects Extra Vehicular Activity of Space Shuttle crews has in relation to decompression sickness as well as how to prevent DCS. A listing of protocols that used C-Chamber from 1983 to 2005 is in Webb (2009) for hypoxia and DCS, some of which used a robotic arm to manipulate the echo-imaging probe used to detect VGE. Equipment testing for aeromedical equipment and training; Center for Sustainment of Trauma And Readiness Skills (C-STARS).

CHAMBER EXPOSURE TERMINATION (RECOMPRESSION) CRITERIA

Note: The exposure should be terminated as soon as any symptoms of DCS are recognized, based on the medical judgment of the Medical Monitor or Medical Observer. If that assigned individual is not immediately available, any staff member (chamber technician, echo technician, aerospace physiologist, investigator) can terminate the exposure at any time there is evidence of symptoms defined herein as DCS, or if there is other danger to the subject.

The subject may terminate the test at any time for any reason.

Pain symptoms are the most common symptom of altitude DCS.
[THIS SCALE IS USED ONLY FOR PAIN SYMPTOMS]

1. **Severity**

0	No pain
1-2	Mild
3-4	Moderate
5-7	Strong
8-9	Severe
10	Strongest imaginable

2. **Intermittent vs. Constant**
   a. **Intermittent pain** (Transient) is defined as mild to moderate pain (severity 1-4) for less than 60 seconds each occurrence. If these intermittent pains recur for **30 min (maximum, once recognized/described by the subject as pain)** from their first occurrence, the exposure will be terminated. Typically, transient pains do not last that long and do not require termination. If the pain severity exceeds 4, the exposure will be terminated even if it is intermittent. Rationale: Pain can result from muscle strain and other factors and it may take some time to determine if the pain is due to DCS or the various exercises and body positional factors.
   b. **Constant pain** is defined as any pain lasting more than 1 minute **once recognized/described by the subject as pain**.

Rationale: Once a constant pain has been identified and communicated, the test termination criterion has been met and there is no reason to continue the exposure.

The exposure should be terminated when the pain meets the criteria of being DCS pain as shown in the table below.

CRITERIA	SYMPTOM DESCRIPTION
Not DCS	1) Intermittent, mild to moderate pain (Severity = 1-4) 2) Intermittent or constant musculo-skeletal awareness, "fullness" or stiffness. “Discomfort,” “ache” or “soreness” requires further clarification.
DCS	**Constant pain (lasting more than 1 minute), of any severity (1-10). Intermittent pain that is greater than moderate (Severity > 4)**

Paresthesias are the 2nd most common symptom of altitude DCS.

1. **Symptoms include:**
   tingling
   pins and needles
   itching
   hot/cold sensation in skin
   numbness

   Note: The 0-10 unit severity scale does not apply to paresthesias. The severity scale only applies to pain symptoms.

2. **Intermittent vs. Constant Paresthesia**
   a. **Intermittent** (Transient) is defined as lasting fewer than 60 seconds each occurrence, in a single extremity, in a non-dermatomal pattern. If these intermittent paresthesia symptoms recur for **30 min (maximum, once recognized/described by the subject)** from their first occurrence, the exposure will be terminated. Typically, transient paresthesias do not last that long and do not require termination.
      Rationale: Paresthesia can be due to body position, exercise pressure points, hyperventilation, hypoxia, thermal and other non-DCS related causes. Additional time may be required to integrate a number of factors and make the determination that the paresthesia is DCS. Single-extremity paresthesia in the absence of other symptoms is not considered to be a serious condition.
   b. **Constant single extremity, non-dermatomal paresthesia** can be defined as DCS requiring exposure termination if it lasts more than 60 sec. However, it may take longer than 60 sec to determine the diagnosis.
      Rationale: Same as above

3. **Migratory (moving around), trunkal (chest and abdomen), dermatomal, or multiple site paresthesia** (in the absence of hyperventilation or hypoxia) is defined as DCS requiring exposure termination with no delay.
   Rationale: These symptoms can suggest central neurological involvement, and in general, represent unambiguous DCS symptoms. Therefore, the test termination criteria are met and there is no benefit to continuing the test once these symptoms are recognized.

Skin manifestations.

1. **Skin mottling or marbling (cutis marmorata; red to purple skin discoloration)** requires exposure termination with no delay.
   Rationale: These symptoms of DCS could be considered to be either of local or CNS (mostly in diving DCS) origin.

Multiple or systemic symptoms of any degree, or multiple-site symptoms require exposure termination **with no delay.**

Rationale: Multiple symptoms or multiple sites are, in general, unambiguous signs of DCS and therefore the exposure termination criteria have been met.

Serious symptoms include cardiopulmonary, spinal neurological, and cerebral neurological symptoms, **all of which require recompression to ground level without delay**. Cardiopulmonary symptoms known as “chokes” include any of the triad of symptoms: cough, dyspnea (difficult or labored breathing), and substernal distress (tightness/pain in chest). Neurological symptoms include abnormal reflex, ataxia (incoordinate movements), blurred vision, cold sweat, dizziness, fatigue (inappropriate or sudden onset), headache, hyperesthesia (increased sensitivity to stimulation), light headedness, loss of consciousness, muscular weakness including paralysis, nausea, numbness, pallor, tremor, shakes, and vertigo.

Rationale: Potentially serious symptoms require prompt exposure termination to protect subjects from progression to a more serious condition. Cardiopulmonary symptoms may rapidly develop into life threatening circulatory collapse.

Left ventricular gas emboli (LVGE) can be detected during Echo Imaging of the heart. When LVGE are detected, the exposure should be **immediately terminated**. The subject with LVGE should be closely observed for symptoms of cerebral gas emboli.

Venous gas emboli (VGE) observed in the right side of the heart using echo imaging are NOT used for exposure termination. VGE do not correlate well with DCS symptoms and should not be used in the process of deciding test termination.

Hyperventilation symptoms require careful scrutiny to distinguish them from DCS symptoms. Symptoms of hyperventilation are usually bilateral. Paresthesias usually occur in distal extremities. Tingling or numbness around the lips is frequently observed. The subject may also complain of dizziness, light-headedness, visual impairment, spasms in hands and feet. Soothing advice to slow the rate of breathing may be helpful when hyperventilation is suspected. Modulation of breathing rate will not resolve symptoms of DCS. If in doubt, recompress. Emergency recompression is not needed for hyperventilation unless systemic or multiple symptoms of DCS cannot be excluded.

CONSENT FOR USE OF PERSONAL PICTURES

Date_____

1. I hereby authorize USAFSAM or other USAF personnel to use videotape pictures, still pictures, or motion pictures, which are taken of me during hypobaric chamber exposures, for training of USAF and other medical and flying personnel. I also authorize the use of the pictures in scientific or safety presentations or publications which may be shown or disseminated to both private or public (other then Department of Defense) audiences. I understand that this statement only authorizes only the use of my pictures and that I will not be identified by name, social security number, or any other identification system which would be available to general public. I realize, however, that someone who knows me personally may view these pictures and to this extent my identity may be compromised.

2. I understand that my consent for use of these pictures is voluntary and may be revoked by me at any time. If I choose to revoke this consent, I must notify USAFSAM.

_____
Volunteer Name/Grade/SSN
(Printed or Typed)

_____
Volunteer Signature

_____
Witness Name (Printed or Typed)

_____
Witness Signature

CONTACTS

Function	Name	Phone #	Email address
Schedule Altitude Research Training			
Schedule ARTS Physical Exams			

DATA ACQUISITION SYSTEM CHECKLIST

1. Turn on power-strip on the desk.
2. Turn on large power-strip on the floor.
3. Wait until monitors display “PLEASE CHECK SIGNAL CABLE”
4. Turn on computer (upper right hand button on the computer keyboard).
5. Wait for MacLab to run (bottom monitor will have a 14 channel display).
6. Using the mouse on the top screen, click “A” for flights requiring Acquisition (recording) of data or “C” for just Chamber data display. If display of Chamber data or Acquisition (recording) of same is needed, follow steps “a” through “e”, for flights not requiring even display of data, skip to step 7.
    a) Turn on the Respitrace and pulse oximeter; as required.
    b) Turn on power-strip by the lap-top computer.
    c) Open lap-top computer and turn it on.
    d) Choose “Display Gas concentrations” from opening menu. This will take the Mass Spec out of “standby” mode and into “run” mode.
    e) While chamber is at ground level connect inlet and outlet tubing to the Mass Spec.
7. Click on START on bottom right-hand corner of lower screen (data is now being recorded).
8. After main chamber reaches ground-level, click STOP to stop data recording. If display/acquisition flight, follow steps “a” through “h”, for other flights, skip to step 9.
    a) Turn off the Respitrace and pulse oximeter; if on.
    b) Hit “esc” key on lap-top computer to return to main menu.
    c) Choose “Select Measurement points” from main menu.
    d) Hit “esc” then “F2” then “Enter” twice.
    e) Use the up and down arrow keys to toggle “Request Mode” to “Min Power”
    f) Hit “Enter” then “esc” then “esc” then “esc.”
    g) Choose “Exit to DOS” from main menu.
    h) Turn off power strip by laptop computer
9. Using the mouse on the top screen, pull down menu FILE, and click on SAVE AS.
10. Double click the DATA FILES directory.
11. Double click the “year” directory.
12. Double click the “month” directory.

13. Type the name of the file (e.g., 25Nov97)
14. Click SAVE.
15. Using the mouse on the top screen, pull down menu FILE and click on QUIT.
16. Using the mouse on the top screen, pull down menu SPECIAL and click on SHUT DOWN.
17. Turn off large power-strip on the floor.
18. Turn off power-strip on the desk.

Creating a New File Folder for the Data Collection Station

19. Double click on the Hard Drive Icon (HD) in the upper right corner of screen.
20. Double click on the Applications Icon
21. Double click on the MacLab 3.5 Icon
22. Double click on the Data Files Icon
23. Double click on “2001” Icon
24. Select FILE on the menu bar. Under FILE select NEW FOLDER.
25. A new folder will appear in the “2001” window. Type name of new folder.
26. Close all windows by clicking in the box in the upper left corner of the window.

Changing Date and Time on Macintosh Data Collection System

1. Open Program for data collection
2. Select the “Apple” Symbol on the far left side (the first choice) in the menu bar
3. Select “Date and Time”
4. Change date and time.
5. Select “Enter”

The MAC-based Data Acquisition System has been dismantled at Brooks.

DAY-OF-EXPOSURE WORKSHEET AND SUBJECT BRIEFING

Name _____ Date _____ Study Title _____ Profile ____

1. Have you changed anything about your routine/normal exercise in the previous 24 hours e.g. increased resistance, speed, distance, etc.? (circle one) No Yes

2. Have you had any gas-producing foods (beans, spicy foods, etc.) in the previous 24 hours? (circle one) No Yes

3. Have you had any alcohol since noon yesterday? (circle one) No Yes

4. Have you performed any work for compensation within the past 8 hours or experienced less sleep than normal last night? (circle one) No Yes

5. Have you consumed more than 2 caffeine-containing foods/beverages within the past 4 hours? (circle one) No Yes

6. Did you consume a breakfast that is not normal for you? (circle one) No Yes

7. Have you had any injuries or taken medications not previously reported to us? (circle one) No Yes

8. Please describe any "Yes" answers to the above questions

_____

_____

9. FOR FEMALES ONLY: Date current menstrual cycle began (flow began) _____
   BCP? No Yes Type

_____

I understand that if I develop symptoms requiring hyperbaric oxygen therapy, I may be required to remain in the area for up to 72 hours after the exposure for follow-up checks and/or additional hyperbaric oxygen therapy. I also understand that it is my responsibility to immediately notify the research or chamber technician or medical personnel if any of the following or other abnormal symptoms occur during or after the exposure:

Pain or tightness in a joint	**Blurred vision**	**Difficulty breathing**
Fuzzy feeling in the head	**Dizziness**	**Chest pain**
Unexpected fatigue	**Weakness**	**Chest tightness**
Skin itching or tingling	**Coughing**	**Headache**

_____ _____
Date Subject Signature

Remainder of this form to be completed by Research Technician

Pre-flight Wt _____#_____kg Height _____ Inches _____ cm

Post-flight Wt _____#_____kg Mask # _____ Alt _____

DRUG AND ALCOHOL TESTING POLICY; CONTRACT SUBJECTS

Contractor information

TEST SUBJECT POLICY

DRUG AND ALCOHOL TESTING POLICY FOR CONTRACT TEST SUBJECTS:

The contractor maintains a strong commitment to its employees to provide a safe workplace and to establish programs promoting high standards of safety and health. Our drug and alcohol policy is part of that commitment to maintain a drug-free workplace.

CONSENT FOR DRUG AND ALCOHOL TESTING:

As a condition of being considered as a test subject, I consent to undergo breath, blood and/or urine tests for the presence of alcohol and illicit drugs. If such tests are found to be positive, I understand that I will not be considered for assignment with the Company. I further agree that results of these breath, blood and/or urine tests shall be made available to the Company and its designated employees or agents.

THE UNDERSIGNED FURTHER STATES THAT HE OR SHE HAS READ THE FOREGOING CONSENT FORM AND KNOWS THE CONTENTS THEREOF AND SIGNS THE SAME OF HIS OR HER OWN FREE WILL.

_____

Signature

_____

Date

DUAL-CYCLE ERGOMETRY WORKSHEET

(Printable from USAFSAM Altitude DCS Research Database)

Name (Last, First MI) **Age: yy.y** **MaxHR: nnn**

Date: _____ VO2peak (l/min): n.nn

Arm Height: _____ Arm Length: _____ Seat Height: _____

Dual-cycle @ 75% of VO2peak (60 rpm on both legs and arms)

Start: _____ **Stop:** _____

Start: _____ **Stop:** _____

Minute	**Leg kp @ 75%**	**Arm watts@ 75%**	**Target HR**
0-11.0	N/A	N/A	
1-2n.n	N/A	N/A	
2- n.n	nn	nnn	

Dual-cycle @ 30% of VO2peak (60 rpm on both legs and arms)

Start: _____ **Stop:** _____

Minute	**Leg kp @ 30%**	**Arm watts@ 30%**	**Target HR**
0-15	**n.n**	**nn**	**nnn**

EXPERIMENTAL DATA WORKSHEET

Protocol Title
(# IRB number), approval date

Altitude (pressure mm Hg) duration – Profiles (circle one)

Date _____ Medical Monitor _____ Notify FEH _____

Subject Name Mask # Begin/End exercise

1. _____ _____ _____/_____

2. _____ _____ _____/_____

Start Ascent _____ Arrive at altitude _____ VHS Tape # _____

Start Descent 1)_____ Arrive at GL 1)_____ **MFN** 1)_____
2)_____ 2)_____ **MFN** 2)_____

CLOCK Time	MSN Time	SUBJ #	FRAME #	GEN	LL	RL	LA	RA	Remarks

EXPERIMENTAL DATA WORKSHEET(Page 2 of 2)

Protocol Title

CLOCK Time	MSN Time	SUB J #	FRAME #	GEN	LL	RL	LA	RA	Remarks

Comments

_____

_____

_____

_____

_____

FLIGHT SUPERVISOR ALTITUDE RESEARCH CHECKLIST – POSTFLIGHT

ALL PURPOSE CHECKLIST		PAGE 1 OF 1		
TITLE/SUBJECT/ACTIVITY/FUNCTIONAL AREA		OPR:	DATE:	
FLIGHT SUPERVISOR ALTITUDE RESEARCH CHECKLIST		**POST-FLIGHT**	**USAFSAM**	
NO.	**ITEM** (Assign a paragraph number to each item. Draw a horizontal line between each major program.)	**YES**	**NO**	**N/A**
1. Notify the PTO before starting the chamber down				
2. Notify the PTO and Medical Monitor once the flight is finished				
3. Medical Monitor may post-flight the subject(s), but Flight Supervisor should do it too and give the subject(s) a "subject contact information" card. Post-flight briefing consists of:				
A.	Refrain from strenuous activity for 12 hours			
B.	Avoid consumption of alcohol for 12 hours			
C.	Valsalva frequently throughout the night following exposure			
D.	Potential symptoms of delayed decompression sickness:			
	PAIN OR TIGHTNESS IN A JOINT OR MUSCLE			
	HEADACHE			
	DIZZINESS			
	UNEXPECTED VISION			
	LIGHT HEADEDNESS			
	NAUSEA			
	VISUAL DIFFICULTIES			
	UNUSUAL WEAKNESS OR FATIGUE			
	CHEST PAIN OR TIGHTNESS IN CHEST			
	COUGHING			
	DIFFICULTY BREATHING			
	HOT OR COLD SENSATIONS			
	COLD SWEAT			
	NUMBNESS			
	SKIN ITCHING OR TINGLING			
	SKIN RASH OR DISCOLORATION			
	ANY OTHER UNUSUAL OR PAINFUL SYMPTOMS			
4. Subject Contact Information Card given to subject				
5. Ensure subject(s) are monitored during post-breathe (change-out oxygen equipment)				
6. Record subject's postflight weight on the Day-of-Exposure Worksheet and Subject Briefing (usually on clipboard near the medical exam room close to Chamber C)				
7. Ensure PTO and contractor personnel are notified once the subject's post-breathe is complete				
8. Ensure chamber is de-crewed and prepared for the next flight				

FLIGHT SUPERVISOR ALTITUDE RESEARCH CHECKLIST – PREFLIGHT

ALL PURPOSE CHECKLIST		PAGE 1 OF 2		
TITLE/SUBJECT/ACTIVITY/FUNCTIONAL AREA		OPR: USAFSAM	DATE:	
FLIGHT SUPERVISOR ALTITUDE RESEARCH CHECKLIST		PRE-FLIGHT	USAFSAM/HEPG	
NO.	ITEM (Assign a paragraph number to each item. Draw a horizontal line between each major program.)		YES	NO	N/A
1. CHAMBER IN CORRECT CONFIGURATION FOR TODAY'S FLIGHT?					
2. TEST SUBJECT QUALIFICATIONS:					
A.	Current AF Form 702, AF Form 1042, orders, review subject history				
B.	Protocol informed consent document (ICD) signed and witnessed				
C.	Supervisor consent form, privacy act signed				
D.	Safety, DCS symptoms, trapped gas briefings complete				
E.	Subject datasheet completed and signed				
F.	Confirm Medical Monitor's availability after flight, i.e., "Will you be on leave or TDY within the next 5 working days?" If so, Notify Admin section if Medical Monitor				
G.	Fill out Subject Information on Medical Record Narrative Summary; SF 502				
3. CREW INSPECTION					
A.	Crew present at the posted show time				
B.	Operating instructions reviewed and signed				
	AAO 11-1				
	AAO 44-1				
	AAO 91-1				
	USAFSAM OI 161-2				
C.	Emergency procedures O.I reviewed for all crew positions				
D.	Protocol reviewed and signed				
E.	Ensure inside observers comply with pre-breathe schedule				
4. CREW BRIEFING					
A.	Type of flight				
B.	Protocol profile				
C.	Ascent time/Crew relief time				
D.	Estimated time for ear and sinus check				
E.	Subject history				
F.	Inside observer ascent time				
G.	Emergency procedures				
5. TEST SUBJECT MEDICAL ASSESSMENT AND READINESS FOR FLIGHT					
A.	SF Form 502 completed and subject declared fit by medical observer				
B.	Urine pregnancy test results obtained (female subjects)				
C.	Ensure that subject can connect/disconnect from or to portable and chamber oxygen supply				
D.	Ensure all pens, watches, and lighters are removed before personnel enter the chamber				
E.	Ensure subject(s) fitted with MBU 5/P or 12/P mask, and cloth student helmet, if needed				

NO.	ITEM (Assign a paragraph number to each item. Draw a horizontal line between each major program.)	YES	NO	N/A
6.	ENSURE THAT SUBJECT CAN CONNECT/DISCONNECT FROM OR TO PORTABLE AND CHAMBER OXYGEN SUPPLY			
7.	ENSURE ALL PENS, WATCHES, AND LIGHTERS ARE REMOVED BEFORE PERSONNEL ENTER THE CHAMBER			
8.	ENSURE SUBJECT(S) ARE FITTED WITH MBU 5/P OR 12/P MASK, AND CLOTH STUDENT HELMET, IF NEEDED			
9.	PERFORM INTERCOM CHECK			
10.	GET PERMISSION FROM AP (AEROSPACE PHYSIOLOGIST) BEFORE STARTING EAR AND SINUS CHECK			
11.	ENSURE LEVEL-OFF GAS SIGNAL IS DEMONSTRATED DURING THE EAR AND SINUS CHECK			
12.	NOTIFY AP, MEDICAL OBSERVER, AND INVESTIGATOR OF ANY SUBJECT REACTIONS/SYMPTOMS			
13.	ENSURE CORRECT GASES FOR EACH PROTOCOL ARE BEING USED			
14.	AT THE SHIFT CHANGE, BRIEF THE ON-ONCOMING FLIGHT SUPERVISOR			
A.	Chamber Profile and Protocol, including Subject Breathing Gas			
	N2O2; 100% or 50:50			
	EEP3; 30 or 60-min prebreathe			
	Break-in-Prebreathe; 30-10-30			
	LASIK; 10K or 35K			
B.	IO exposure time			
C.	Identify the on-coming chamber crew, to include AP, Medical Observer, and Subjects			

REFER TO FLIGHT PROFILE FOR ANY SPECIAL INSTRUCTIONS

ENSURE INSIDE OBSERVERS GO IN/ON STANDBY AT THE PRESCRIBED TIMES

LOCATION OF USAFSAM DECOMPRESSION SICKNESS RESEARCH FILES

Item	Location of Completed Forms/Worksheets/etc.
USAFSAM Altitude DCS Research Database	(N:)\FE\FEA\Reference Project\DCS.mdb
USAFSAM Altitude DCS Research Database Documentation	USAFSAM-FE-BR-TR-2009-nnnn
USAFSAM Altitude DCS Literature Database	(N:)\FE\FEA\Reference Project\DCSbiblio.mdb
Air Force Fitness Assessment printout	Subject Exposure History Folder
ARTS Health History Worksheet	Subject Exposure History Folder
ARTS Record	Altitude and Acceleration Operations Administrative Support office
ARTS Safety Training Checklist	ARTS Record-V
ARTS Supervisor Consent Letter	ARTS Record-V
ARTS Worksheet	ARTS Record-I; copy in Subject Exposure History Folder
Certified Orders	ARTS Record-VI
Chamber Reactor/Treatment Report (AF Forms 361EF)	ARTS Record-IV
Day of Exposure Worksheet and Subject Briefing	Subject Exposure History Folder
Dual-Cycle Ergometry Worksheets	Subject Exposure History Folder
Experimental Data Worksheets	Laboratory notebooks for each protocol
Flight Supervisor Altitude Research Checklist-Postflight	
Flight Supervisor Altitude Research Checklist-Preflight	
Individual Physiological Training Record (AF Forms 702)	ARTS Record-I
Informed Consent Documents, copies	With PI
Laboratory notebooks for each protocol	Contractor lab
Medical Care Memo	
Medical Recommendation for Flying or Special Operational Duty (AF Form 1042)	ARTS Record-I
Medical Record (SF Forms 502)	ARTS Record-III & IV
Medical Records Review Memo	
Military Pay Order (DD Forms 114)	ARTS Record-VI
Personal Pictures Consent Form	ARTS Record-V
Privacy Act (DD Form 2005)	ARTS Record-V
Protocol and ICD, originals	Delivered to IRB

Request for Orders	ARTS Record-VI
Research reports emanating from data	Literature
Special Orders	ARTS Record-VI
Subject Exposure History Folder	Contractor lab
Video tapes of echo-imaging sessions	Contractor lab
Workunit files	PI

The appendices to this guide contain blank worksheets for many of the above. Handouts are also alphabetically listed in the appendices.

MEDICAL CARE MEMO

DEPARTMENT OF THE AIR FORCE

Date

MEMORANDUM FOR ALL ALTITUDE RESEARCH TEST SUBJECTS (ARTS)

FROM: Chamber Operations OIC

SUBJECT: Medical Care

1. In order to prevent delayed or canceled research flights due to medical clearance issues and other related problems, the following procedures must be followed:

a. Your medical records will be maintained in the Flight Surgeon's Office (FSO).
b. The local flight surgeon is your primary health care provider. Any medical care you need must be received from the FSO.
c. If for some reason you receive medical care outside the FSO, you must call the FSO the next duty day during sick call for aeromedical disposition (this is for your safety). If you don't report to the FSO, the flight surgeon will automatically remove you from flight status ("grounded").
d. If you are medically removed from flight status, you need to report to the FSO to get back on flight status ("ungrounded") before you can be scheduled for a flight. Return to subject status **is not** automatic. Please ensure your follow-up, even if you are feeling better.
e. If you are removed from (off) flight status. you will not be scheduled for a flight.
f. Female subjects: Report to the FSO ***the day before the flight*** for a pregnancy test. Exception: Monday flights; report to FSO at 0700 hrs on that Monday.

2. Please follow these procedures; they are necessary for your safety. With your help we can ensure you receive proper medical care and clearances in a timely manner. Your cooperation is appreciated and will assist us in making your flights run as smoothly as possible. If you have any questions please feel free to contact me.

Chief, Altitude and Acceleration Operations

MEDICAL RECORD	NARRATIVE SUMMARY (CLINICAL RESUME)	
DATE OF ADMISSION	DATE OF DISCHARGE	NUMBER OF DAYS HOSPITALIZED

(Sign and date at end of narrative)

I. Protocol Title: _____ Total prebreathe time: ____ Pre-exposure Exercise: ____

II. Preflight HISTORY

	Check if Yes	Comments
A. Changes since the last PE:		
1. General health change?		
2. Dental work/surgery?		
3. Donated blood within past week?		
B. ENT Symptoms?		
C. Musculoskeletal:		
1. Fatigue?		
2. Any recent hard exercise?		
3. Muscle/joint symptoms?		
D. Skin reactivity?		
E. Diving/Flying within 72 hours?		
F. Medications and Allergies:		
1. Prescription/OTC drugs?		
2. Herbal/nutritional?		
3. Drug/other allergies?		

III. Preflight EXAMINATION A. Blood Pressure _____ B. Pulse _____ C. Weight _____

C. Ears/nose/throat normal?		
D. Skin erythema/pigment?		
E. Pregnancy test (females) negative		

Certified by: _____

IV. Cleared for today's altitude chamber flight: Yes/No _____

Medical Observer's Signature and Stamp

V. Postflight HISTORY

A. Nature and grade of reaction: _____

Time of reaction: _____ Altitude of reaction:

Time of resolution: _____ Altitude of resolution:

B. Nature and grade of reaction:

Time of reaction: _____ Altitude of reaction:

Time of resolution: _____ Altitude of resolution:

C. Total time at peak altitude: Time of arrival at ground level: _____

D. Symptom occurrence:	Check if Yes	Comments
Musculoskeletal:		
Skin:		
Paresthesia:		
Neurological:		
Respiratory:		
Cardiovascular:		

(Use additional sheets of this form (Standard Form 502) if more space is needed.)

SIGNATURE OF PHYSICIAN	DATE	IDENTIFICATION NO.	ORGANIZATION

PATIENT'S IDENTIFICATION	*(For typed or written entries give: Name-last, first, middle; grade; rank; hospital or medical facility)*	REGISTER NO.	WARD NO.

NAME _____ GRADE/RANK _____ NARRATIVE SUMMARY (CLINICAL RESUME) MEDICAL RECORD
SOCIAL SECURITY NO. _____ DATE OF BIRTH_____ AGE _____

STANDARD FORM 502 (REV. 7-91)
Described by GSA/ICMR, FIRMR (41 CFR) 201-9.202-1

EXCEPTION TO SF 502
502-118 APPROVED BY NARS AUG 2, 1976 NSN 7540-00-634-4114

MEDICAL RECORD	NARRATIVE SUMMARY (CLINICAL RESUME)	
DATE OF ADMISSION	DATE OF DISCHARGE	NUMBER OF DAYS HOSPITALIZED

(Sign and date at end of narrative)

VI. Postflight EXAMINATION	Normal	Abnormal	N/E	Comments
A. Musculoskeletal:				
Range of motion				
Strength				
Pain/Guarding				
Crepitus				
Stability				
B. Skin				
Pruritus				
Mottling				
Urticaria				
Edema				
Petechiae				
C. Respiratory Tract				
Sinuses				
Ears/Nose/Throat				
Lungs				
D. Nervous System				
Mental status				
Cranial Nerves II-XII				
Deep tendon reflexes				
Cerebellar function				
E. Paresthesia				
Light touch sensation				
Vibratory sensation				
Proprioception				
F. Cardiovascular				
Heart				
Blood pressure				
Pulses				

VII. SUMMARY

_____

_____

_____

VIII. FINAL DIAGNOSIS

_____

_____

_____

IX. Postflight PLAN

	Check if Yes		Check if Yes
A. Subject reminded to report, should further symptoms develop:	☐	C. Subject administered two hour 100% oxygen post-breathe:	☐
B. Subject reminded about oxygen ear:	☐	D. Subject referred to Hyperbaric Medicine:	☐

(Use additional sheets of this form (Standard Form 502) if more space is needed.)

SIGNATURE OF PHYSICIAN	DATE	IDENTIFICATION NO.	ORGANIZATION

PATIENT'S IDENTIFICATION	*(For typed or written entries give: Name-last, first, middle; grade; rank; hospital or medical facility)*	REGISTER NO.	WARD NO.

NAME _____ GRADE/RANK _____ NARRATIVE SUMMARY (CLINICAL RESUME) MEDICAL RECORD
SOCIAL SECURITY NO. _____ DATE OF BIRTH_____ AGE _____

STANDARD FORM 502 (REV. 7-91)
Described by GSA/ICMR, FIRMR (41 CFR) 201-9.202-1

MEDICAL RECORDS REVIEW MEMO

DEPARTMENT OF THE AIR FORCE

Date

MEMORANDUM FOR: Altitude Research Test Subject
FSO
In Turn

FROM:

SUBJECT: Medical Records Review (Altitude Research Test Subject)

1. In order to fulfill the medical requirements for becoming a hypobaric subject, please call the Physical Exams Section at the FSO for a complete medical records review. Physical Exams will set an appointment for your physical after the medical records review.

2. If you have any questions, please contact the Research Technician or the Altitude and Acceleration Operations Section.

1st Ind, FSO

TO:

The following individual is scheduled for a hypobaric subject physical on _____

Name: _____
SSAN: _____
Duty Phone: _____

_____
Signature of Aeromedical Technician

PROTOCOL-SPECIFIC EQUIPMENT PROCEDURES

1. EEP (example)

a. 3 Lead EKG
b. Pulse Oximeter (available in chamber)
c. Polar Heart Rate Monitor (preflight)
d. Timer (preflight)
e. Exercise Variables (preflight; 75% & 30% of VO2peak, complete *Dual-Cycle Ergometry Worksheet*
f. Ambulatory EVA exercises at altitude

2. N2O2 (example)

a. Mass Spectrometer on for N2O2 Protocol, 50:50 profile (Test #4; Profile D) or any other profile not using 100% oxygen
b. 3 Lead EKG
c. Pulse Oximeter (available in chamber)
d. Ambulatory EVA exercises at altitude

SAMPLE EMAIL TO NOTIFY ARTS OF NEXT MONTH'S SCHEDULE

The following days in **April, 2009**, are reserved for altitude research test subject exposures: 1, 3, 4, 9, 11, 12, 15, 18, 19, 22, 23, 25, 29, 30

Please respond within 10 days of receiving this email. Type in the dates you are available and click "Reply" (please **don't** hit "Reply to All"):

Primary Choice _____

First Alternate _____

Second Alternate _____

A Distribution List for current subjects who have not completed all available exposures will be maintained and used in the To: block of the email.

SAMPLE TEST PLAN

PROTOCOL TITLE[5]

Environmental Conditions
 # F-BR-20NN-0NNN-H approval date
[***Chamber crew involvement in italics, bracketed, boldface***]

PREPARATION FOR EXPOSURE

Note: The times shown below, prior to beginning preoxygenation on the day of exposure, are suggestions for timing which may assist in the smooth accomplishment of these required actions.

CLOCK
TIME ACTIVITY

0730-0815
- Set up/recheck chamber equipment
- Ensure dual-cycle ergometer/s are available and oxygen supply is at hand
- Ensure SONOS 1000 available and functional
- Subject arrives
- Subject weight recorded
- Subject Medical Questionnaire completed
- Subject questioned by Investigator, Research Technician, or Aerospace Physiologist regarding any changes in health and physical condition and whether they complied with the conditions listed in the ICD; no hyperbaric exposures w/i 72 h, etc., and blood pressure checked.
- Physical exam by Medical Monitor
- Subject receives briefing on procedures [***chamber crew***]
- Pre-exposure Echo-imaging
- Notify Hyperbaric Medicine group of exposure profile/subject

0815-0827
- [***Ear and sinus check to 5000 ft***]

0830-0840
- [***Subject's exercise-enhanced preoxygenation with 100% oxygen at 75% of VO_{2peak}***]; after connection to the oxygen regulator, subject takes two, slow, deep breaths and then breathes normally for the remaining preoxygenation time

0840-0855
- Subject performs dual-cycle ergometry at 30% of VO_{2peak}

0855 Subject walks into chamber and prepares for ascent
- [***Ensure that chamber crew is ready for ascent***]

[5] Page header should contain: Start Ascent time TESTPLAN for Profile n (n Subject/s) Page #"

ASCENT AND EXPOSURE

(the times may be based on Exposure Time with a timer hacked at time zero to alleviate problems if the exposure does not begin at the time listed below)

0900 Subject begins ascent breathing 100% oxygen
[Begin ascent to nn,000', n.nn psia, nnn mmHg at 5,000ft/min]

090n Arrives at exposure pressure
[Level-off Check]

0906-0910 torque wrench

0910-0914 rope pull

0914-0918 Echo-imaging station

0918-0922 cycle

0922-0926 torque wrench

0926-0930 rope pull

0930-0934 Echo-imaging station

0934-0938 cycle

0938-0942 torque wrench

0942-0946 rope pull

0946-0950 Echo-imaging station

0950-0954 cycle

0954-0958 torque wrench

0958-1002 rope pull

1002-1006 Echo-imaging station; Check for cutis marmorata

1006-1010 **REST**

1010-1014 cycle

1014-1018 torque wrench

1018-1022 rope pull

1022-1026 Echo-imaging station

1026-1030 cycle

1030-1034 torque wrench

1034-1038 rope pull

1038-1042 Echo-imaging station

1042-1046 cycle

1046-1050 torque wrench

1050-1054 rope pull

1054-1058 Echo-imaging station; Check for cutis marmorata

1058-1102 cycle

1102-1106 torque wrench

1106-1110 **REST**

1110-1114 rope pull

1114-1118 Echo-imaging station

1118-1122 cycle

1122-1126 torque wrench

1126-1130 rope pull

1130-1134 Echo-imaging station

1134-1138 cycle

1138-1142 torque wrench

1142-1146 rope pull

1146-1150 Echo-imaging station; Check for cutis marmorata

1150-1154 cycle

1154-1158 torque wrench

1158-1202 rope pull

1202-1216 Echo-imaging station

1206-1218 **REST**

1218-1222 cycle

1222-1226 torque wrench

1226-1230 rope pull

1230-1234 Echo-imaging station

1234-1238 cycle

1238-1242 torque wrench

1242-1246 rope pull

1246-1250 Echo-imaging station

1250-1254 cycle

1254-1258 torque wrench

1258-1302 rope pull

1302-1306 Echo-imaging station; Check for cutis marmorata

1306-1310 **REST**

1310-1314 cycle

1314-1318 torque wrench

1318-1322 rope pull

1322-1326 Echo-imaging station

1326-1330 cycle

1330-1334 torque wrench

1334-1338 rope pull

1338-1342 Echo-imaging station

1342-1346 cycle

1346-1350 torque wrench

1350-1354 rope pull

1354-1358 Echo-imaging station; Check for cutis marmorata

1358-1402 cycle

1402 [Predescent Check]

1405 [Begin Descent; 5000 ft/min]

1410 Chamber arrives at ground level
Post-exposure medical exam
Subject/s begin post-breathe

1610 Post-exposure briefing
Weigh-in Release of subject

SUBJECT APPRECIATION LETTER (SAMPLE)

DEPARTMENT OF THE AIR FORCE

Date

MEMORANDUM FOR (SUBJECT'S SUPERVISOR)

FROM: USAFSAM

SUBJECT: Letter of Appreciation

1. Please extend my sincere appreciation to SOMEBODY, for volunteering as an Altitude Research Test Subject for Decompression Sickness Research. His/her support of programs including, but not limited to, the F-22, Special Operations, CV-22 is invaluable. Volunteering to verify the level of risk and protection offered by various experimental preventive measures, demonstrates his/her interest in and commitment to the future of the Air Force. His/her flexibility and willingness to participate in long, tedious altitude exposures is also commendable.

2. The efforts of SOMEBODY and other volunteers like him/her directly contributes to the Laboratory's attempts to solve the human challenges in Air Force systems and operations. Their dedication enables us to improve crew performance and safety through gaining a better understanding of the operational stress environment.

3. Again, my thanks to SOMEBODY and also his/her supervisor for supporting our research program.

Chief, NNN Division

SUBJECT CONTACT INFORMATION CARD

Before or after each exposure, each subject is given a card bearing the contact numbers to call in the event of any symptom development. It also lists restrictions in activity, recommendations, and DCS symptoms:

DCS SYMPTOMS CAN INCLUDE: Pain or tightness in a joint or muscle, headache, visual difficulties, light headedness, dizziness, nausea, unusual weakness or fatigue, chest pain, tightness in chest, coughing, difficulty breathing, hot or cold sensations, cold sweat, numbness, skin itching, skin tingling, skin rash or discoloration, any other unusual or painful symptoms

REMEMBER TO: Valsalva frequently throughout the evening and, refrain from strenuous activity and alcohol for 12 hours

CONTACTS:

0730-1615 M-F; (phone number)

Hyperbaric Medicine; (phone number)

Command Post; (phone number)

Tell them you are a research subject with symptoms requiring immediate notification of Hyperbaric Medicine.

SUBJECT EXPOSURE HISTORY FOLDERS

The folders are kept in the Contractor lab. Individual folders for each subject include:

Left Panel

ARTS Worksheet

ARTS Health History Worksheet

Copies of the ICD signature pages for each protocol in which the subject participates

Copy of subject's AF Fitness Assessment printout (as required)

Dual-Cycle Ergometry Worksheets

Right Panel

Day-of-Exposure Worksheet and Subject Briefing

SUMMARY OF DECOMPRESSION SICKNESS RESEARCH

(for potential Altitude Research Test Subjects)

This description is intended to give you a general overview of the USAF altitude research program and advise you about what is expected of you as a test subject. It can also provide additional information for your supervisor and/or other interested persons, possibly for inclusion in performance reports or awards.

Crew operations in high altitude aircraft and space vehicles require protective measures to overcome the physiological hazards of the hypobaric environment. Despite a considerable body of information from previous high altitude experiments, there are still many things to be learned to make altitude exposures safer and more productive for our operational commands and NASA space operations.

Before your exposure to an altitude environment, you will undergo a physical examination at the FSO and attend an Altitude Research Training (ART) class which will teach you the physiology and safety rules of altitude chamber exposure. The ART will help you recognize any symptoms you may have as a result of these exposures and to help ensure the studies are carried out in a safe manner. This training course will include classroom instruction on potential effects of reduced pressure and an altitude chamber exposure.

High altitude exposures can sometimes result in altitude decompression sickness (DCS). Symptoms include pain in joints or muscles, skin sensations, or, less frequently, respiratory and neurologic symptoms. If the symptoms occur during altitude research chamber exposures, the subjects are quickly returned to ground level. The symptoms usually disappear during descent, which may not be an option for astronauts in space, special operations parachute teams, or pilots flying high altitude reconnaissance aircraft. Therefore, it is important to study procedures that can prevent or treat these problems.

You may be required to do strenuous exercise or mild exercise during preparation for the exposure while breathing via a head-neck enclosure mask that has a large viewport in front. You will usually be required to do mild exercises during the exposures to simulate the rate of energy expended during astronaut extravehicular activity. In addition to these exercises, you will spend a 4-minute period lying on your side and back on a flat padded surface while being monitored for venous gas emboli (microscopic bubbles passing through the heart) by echo-imaging. The echo-imaging, like that used during some pregnancy exams, consists of placing a blunt, smooth-ended probe (shaped similar to a microphone) against your chest. This monitoring does not break the skin or cause pain and will occur approximately 4 times per hour. At the end of each exposure, you will normally post-breathe 100% oxygen for two hours. The post-breathing will be accomplished while you are resting outside the chamber.

Before taking part in any specific protocol, you will be briefed on specific risks, procedures involved, and benefits. All chamber exposures will have an Aerospace Physiologist and medical doctor available to help ensure your safety. A trained observer will be on call during the exposures to assist with and maintain all oxygen and communications equipment. You will receive monetary compensation for your time in accordance with military pay regulations (Hazardous Duty Pay - currently $150.00 per month) or $15.45/hour for civilian participants.

We hope this information and the ART will help you feel comfortable with altitude exposures. For additional information, please contact the Research Technician.

SUPPLIES AND VENDORS

Item	Vendor	Phone #
SONOS 1000 Imaging System	Agilent Technologies 9780 S. Meridian Blvd. Englewood, CO 80112	(303) 662-4296
Basic Transducer Cable	Ambulatory Monitoring, Inc. P.O. Box 609 731 Saw Mill River Road Ardsley, NY 10502-0609	(914) 693-9240
Flex Pulse Oximeter Sensor	Government Marketing, Intl. **www.selltothefeds.com**	(843) 821-9364
Resins and Silicones	Hans Rudolph, Inc. 7200 Wyandotte Kansas City, MO 64114	(800) 456-6695
Lab Coats	H&M Uniforms 2712 S. Pleasanton Road San Antonio, Texas 78221	(210) 924-7810
Cidex Solution/Supplies	McKesson HBOC Medical Group 3323 IH 35 North, Suite 100 San Antonio, Texas 78219	(210) 690-8705
Latex Bulb/Air Flow Valve, Luer Connector Set, Extendex	Mission Medical 318 West Nakoma San Antonio, Texas 78216	(210) 344-6666
Ultrasound gel	Moore Medical www.mooremedical.com	(800) 477-3477
Mixed gases	Praxair 4227 Binz-Englemann Rd. San Antonio, Texas 78219	(210) 946-9948
Super VHS Tapes	Protape Bandera Road San Antonio, Texas	(210) 520-8273
Metabolic Measurement Cart maintenance, supplies, etc.		
Monark distributer in USA	Stairmaster **www.stairmaster.com**	(800) 331-3578
Sodasorb Absorbent	United Medical Supply 5400 Rittiman Plaza San Antonio, Texas	(210) 826-5881
Stress Test Electrodes	Vermont Medical, Inc. P.O. Box 556 Industrial Park Bellows Falls, VT 05101	(800) 245-4025
Intramedic tubing	VWR Scientific Products P.O. Box 640169 Pittsburgh, PA 15264-0169	(800) 932-5000

TESTING FOR MAXIMAL AEROBIC CAPACITY

1. General

The test for maximal aerobic capacity (VO_{2max}) requires performance of maximal exercise on a cycle ergometer while his/her expired gas is collected for analysis. The subject will be asked to complete a general health history questionnaire prior to the exercise bout.

2. Equipment

The subject will use the following equipment to perform the test:

A. Dual-cycle ergometer
B. Mouthpiece attached to a two-way valve for the collection of expired gas that will be analyzed.
C. Nose clip to ensure that the subject breathes through his/her mouth only.
D. Adhesive chest electrodes connected to an electrocardiograph.

3. Procedures

A. The subject will be asked to perform a dual-cycle exercise protocol. The bout will begin with the subject exercising against a low resistance for 1 min on the legs only. The leg resistance will be increased then and every 2 min thereafter in a progressive fashion until the termination of the test. One minute into the test, the subject will begin working the arms in addition to the legs. The arm resistance will increase progressively with the leg resistance every 2 min until the termination of the test.
B. The test will continue to exhaustion or until the investigator terminates the test, whichever occurs first. Specific reasons for test termination include (1,2):
    1. The subject requests termination of the test.
    2. The subject is unable to continue the test.
    3. The subject's oxygen consumption plateaus.
    4. The subject experiences chest pain or tightness.
    5. The subject exhibits signs of poor circulation such as light-headedness, confusion, muscular coordination failure, pale or bluish skin, nausea, or cold/clammy skin.
    6. The subject exhibits unusual heart rate or rhythm.
    7. The subject has significant difficulty breathing.
    8. Equipment failure.

4. Discomforts/Risk Management

A. During maximal exercise it is possible, yet unlikely, the subject may experience the following symptoms in response to work of this nature:
    1. Light-headedness.
    2. Muscle soreness (either immediate or delayed onset).
    3. Nausea.
    4. Abnormal response of the cardiovascular system.
    5. The following steps will be taken to minimize and manage the risks associated with this test:

6. Guidelines set forth by the American College of Sports Medicine (1) will be followed to ensure all subjects are in adequate health prior to performing any exercise test.
7. An investigator or Research Technician experienced in exercise science and human performance, and the associated hazards will supervise exercise testing sessions.
8. The subject will be briefed and will indicate his/her understanding of the exercise procedures and the hazards by signing the informed consent document for the appropriate study.

5. References

American College of Sports Medicine. ACSM's Guidelines for Exercise Testing and Prescription (5th Ed.). Baltimore: Williams and Wilkins. 1995.

Howley ET, Bassett DR, Welch HG. Criteria for maximal oxygen uptake: Review and commentary. Med Sci Sports Exer. 1995;27:1292-1301.

ACRONYMS

ART	Altitude Research Training (Research Subject Training Course)
ARTS	Altitude Research Test Subject
BCP	Birth Control Pills
BiP	Break-in-Prebreathe (protocol)
BSI	Bends Screening Index (protocol)
DCS	Decompression Sickness
DNIF	Duty Not Including Flying (cannot be exposed in chamber)
EEP	The Effect of Exercise-Enhanced Prebreathe on Decompression Sickness (DCS) Risk at 25,000 ft (protocol)
EKG	Electrokardiograph (German), electrocardiograph (English)
EVA	Extravehicular Activity
FSO	Flight Surgeon's Office
HDIP	Hazardous Duty Incentive Pay
HC	Hormonal Contraception
HCG	Human Chorionic Gonadotropin (Pregnancy Screen by urine test)
ICD	Informed Consent Document
IRB	Institutional Review Board
LVGE	Left Ventricular Gas Emboli
N2O2	The effect of breathing gas mixtures containing various inert gas levels on decompression sickness (DCS) risk (protocol)
USAFSAM	USAF School of Aerospace Medicine
SONOS	Hewlett-Packard SONOS 1000 Echo-Imaging System
VGE	Venous Gas Emboli